

**CONSTRUCTION INSPECTION HANDBOOK
(360 FW 4)**

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**DIVISION OF ENGINEERING
U. S. FISH AND WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR**

TABLE OF CONTENTS

1.0	<u>INTRODUCTION</u>	<u>PAGE</u>
1.1	Purpose and Scope	1-1
1.2	General	1-1
1.3	Guidelines for Construction Inspectors	1-2
1.4	Authority of Inspection Personnel	1-4
1.5	Preliminary Preparations	1-5
1.6	Value Engineering	1-5
1.7	Barrier-free Accessibility	1-5
2.0	<u>FIELD ADMINISTRATION</u>	
2.1	General	2-1
2.2	Inspector's Daily Logs	2-1
2.3	Project Log Book (Field Diaries)	2-3
2.4	Photographs and Videotape for Record Purposes	2-5
2.5	Project Inspector Files	2-6
2.6	Special Report	2-6
2.7	Substantial Completion Reports (Beneficial Occupancy)	2-8
2.8	Final Inspection Reports	2-9
2.9	Final Acceptance Memorandum	2-9
2.10	Safety Reports	2-9
2.11	As-Built Drawings	2-9
2.12	Payments to Contractor	2-9

TABLE OF CONTENTS (Cont'd)

3.0	<u>TECHNICAL INSPECTION</u>	<u>PAGE</u>
3.1	General	3-1
3.2	Earthwork, Trenching, Site and Finish Grading	3-1
3.3	Soil Treatment for Termites	3-4
3.4	Utilities	3-4
3.5	Concrete	3-5
3.6	Lightweight Concrete	3-9
3.7	Stucco	3-10
3.8	Masonry	3-12
3.9	Structural Steel	3-13
3.10	Steel Doors and Frames	3-15
3.11	Roofing (Membrane, Ballasted and Glued)	3-16
3.12	Asphalt Shingle Roofs	3-17
3.13	Sheet Metal Roofing	3-18
3.14	Standing Seam Metal Roof	3-20
3.15	Ceramic and Quarry Tile	3-22
3.16	Resilient Floor Covering	3-22
3.17	Carpentry and Millwork	3-23
3.18	Insulation Material	3-30
3.19	Acoustical Treatment	3-30
3.20	Drywall Finish	3-31

TABLE OF CONTENTS (Cont'd)

3.0	TECHNICAL INSPECTION (Cont'd)	<u>PAGE</u>
3.21	Glass Glazing	3-32
3.22	Hardware	3-32
3.23	Painting	3-33
3.24	Electrical Work - Interior	3-34
3.25	Electrical Work - Exterior	3-36
3.26	Plumbing	3-36
3.27	Heating, All Types	3-41
3.28	Ventilating Systems	3-47
3.29	Air Conditioning and Refrigeration	3-48
3.30	Testing and Training (HVAC Systems)	3-54
3.31	Gas Distribution	3-54
3.32	Roads	3-57
3.33	Bituminous Prime Coat	3-60
3.34	Hot-Mix Asphaltic Concrete and Bituminous Road Mix Surface Course	3-62
3.35	Water Well Drilling	3-64
4.0	<u>SAFETY</u>	
4.1	Purpose	4-1
4.2	General	4-1
4.3	Reports (Accident)	4-2

TABLE OF CONTENTS (Cont'd)

4.0	<u>SAFETY (Cont'd)</u>	<u>PAGE</u>
4.4	Training	4-3
4.5	Compliance with Federal, State and Local Laws	4-3
4.6	Safety Guidelines	4-4
5.0	<u>FINAL INSPECTION</u>	
5.1	General	5-1
5.2	Scheduling the Final Inspection	5-1
5.3	Pre-Final Inspection	5-1
6.0	<u>LABOR RELATIONS</u>	
6.1	General	6-1
6.2	Labor Standards Interviews	6-1
6.3	Violations of Labor Standards	6-1
7.0	<u>EXHIBITS - CONSTRUCTION CONTRACT MANAGEMENT FORMS</u>	
7.1	Inspector's Daily Log	7-1
7.2	Punch (Deficiency) List	7-2
7.3	Labor Standards Interview	7-3
7.4	Safety Letter	7-4
7.5	Time and Materials Form	7-5
7.6	Pre-Construction Safety Checklist	7-6

1.0 INTRODUCTION

1.1 Purpose and Scope

The purpose of this Handbook is to provide instruction and guidance to the Contracting Officer's Representatives (COR) and Construction Inspectors (CI) in their daily activities. It may also be used as a guide in matters not covered by contract specifications, regulations, and other directives. However, it does not replace or modify any of the clauses or provisions of a construction contract. The term COR/CI in this Handbook refers to the individual(s) responsible for ensuring Contractor compliance with contract terms and conditions.

Project inspection is provided to ensure that the Contractor's work complies with the contract requirements. Many details of construction are not specifically covered in the specifications and are optional with the Contractor. The COR/CI must verify that proper practices are followed and guard against use of unsatisfactory materials or faulty methods.

Inspection is one of the most important elements of construction and contract administration. Good engineering design and properly prepared plans and specifications are essential for a quality end product. However, ensuring that specifications and drawings are adhered to depends significantly upon the COR/CI. This is especially true of larger, more complex projects such as general building construction, which involves many field-made products whose quality is dependent on the use of satisfactory materials and workmanship.

The frequency and method by which a construction project is inspected by the COR/CI depends upon the complexity of the project as well as other factors (see Chapter 4.5E). However, the lack of project inspections due to personnel or funding limitations does not relieve the contractor of compliance with applicable standards/requirements at all times. This Handbook has been prepared to guide inspection activities from initial assignment of the COR/CI through completion of the project.

1.2 General

A. Responsibilities and Duties

1. The COR/CI is responsible for:
 - a. Ensuring that all construction activities comply with contract requirements and that work is performed in accordance with good construction practices.
 - b. Verifying that materials and equipment incorporated into the project meet contract requirements.

- c. Monitoring contract labor requirements.
 - d. Providing adequate and accurate reports.
 - e. Ensuring that applicable construction safety standards are met.
 - f. Verifying that approved Contractor submittals are available before work is performed.
 - g. Verifying that actual construction progress agrees with approved progress schedules.
 - h. Notifying the Historic Preservation Officer immediately if unanticipated archeological materials are encountered during construction so that appropriate action may be taken to preserve such materials.
 - i. Monitoring contract compliance with appropriate Federal Acquisition Regulations (FAR).
- 2. The project COR from the responsible Engineering Office acts as liaison among the CI, the Engineering Office (or architectural/engineering firm) and the CO. Due to this single channel of communication, all other official reporting between the field and other sections can be eliminated.
 - 3. No Service employee may instruct the Contractor, or the Contractor's employee regarding how or when to perform work required by the contract. The COR/CI are responsible for ensuring that the Service gets what it contracted for, but are not responsible for directing the work of the Contractor.
 - 4. Only the CO is authorized to modify the contract. Such changes will be accomplished by a written modification from the CO. The CI is responsible for notifying the COR immediately if an unauthorized employee orders a change in the contract. As a means of expediting changes and precluding possible delays, the CO may verbally direct the Contractor to proceed with a change pending issuance of a formal written modification.

1.3 Guidelines for Construction Inspectors

- A. Following are guidelines that apply to duties and responsibilities of the COR/CI:
 - 1. Know the plans and specifications, and enforce them.
 - 2. Know the specific instructions given by the CO or the COR.

3. When relieving another Inspector, check on the status of work and any special instructions. Pass on pertinent and current information to the CI succeeding you..
 4. Report promptly to the COR any conditions that differ from those in project plans and specifications.
 5. Report all unsafe practices to the COR and advise immediately of any accidents.
 6. If work is not being performed in accordance with plans/specifications, advise the Contractor's Superintendent and note this in the Daily Log. If the work is not immediately corrected, or if there is a disagreement, consult the COR.
 7. Make an accurate, comprehensive record of all work inspected by completion of Daily Logs while on-site (See Section 2.2).
 8. Maintain a courteous and tactful attitude, but never become complacent in inspection duties.
 9. Consult the COR if a question arises that you cannot answer.
- B. The COR/CI's conduct is extremely important since the public and Contractor personnel regard the COR/CI as a representative of the Federal Government:
1. Inspection is the keynote of quality construction and calls for technical knowledge, tact and careful judgment to verify production of good quality work.
 2. Careless inspection can lead to poor work and disputes. It is generally through firm, intelligent inspection based on thorough knowledge of construction principles and understanding of potential Contractor's problems that high quality work results.
 3. You should avoid antagonism with the Contractor. Aim to establish an attitude of cooperation and mutual trust in accomplishing work accordance with plans and specifications. Establish the Contractor's confidence in your ability and fairness. Actions which appear to be beyond the range of authority, or arise from an error of judgment or lack of knowledge, can undermine this confidence.

4. Personnel with inspection duties must conduct themselves with dignity, be thorough in their work and take nothing for granted. Dealings with project representatives or employees of the Contractor must be courteous but firm. The quality/quantity of work in plans and specifications must be insisted upon. Decisions must be based upon knowledge of facts and be consistent and reasonable. Unacceptable work must be brought to the attention of the Contractor. All defects must be corrected after discovery (defective work must be noted in the Daily Log).
5. Inspection personnel must be honest and must not grant or accept gratuities/favors that might place them under any obligation to the contractor or create the appearance of a conflict of interest.
6. Be professional in manner, but not overly familiar with the Contractor's personnel.
7. Be courteous to the public, visitors and station personnel. Do not give frivolous answers to what may seem simplistic questions. The public is entitled to courteous answers.
8. Do not waste workers' time with unnecessary conversations.
9. Do not argue. Refer disputed interpretations to the COR and use your best judgment prior to a response.
10. Issue instructions to the Contractor's Superintendent or authorized representative only. Never issue instructions to a foreman or subcontractor's representative except in cases involving personnel safety (See Chapter 4). The prime Contractor's Superintendent is your contact with whom to discuss instructions relative to deficiencies, not the workmen or foreman on the job.

1.4 Authority of Inspection Personnel

All contractual authorities are vested in the CO. However, the COR/CI is authorized to reject or disapprove defective and/or poor materials, equipment and workmanship, and require the Contractor to correct or replace same at no additional cost to the government. If the Contractor refuses or disagrees regarding corrective action, the matter must be reported immediately to the COR. (Refer to Chapter 4 on safety hazards regarding the COR/CI's authority to stop or rectify unsafe practices/conditions.)

1.5 Preliminary Preparations

- A. Plans and specifications should be furnished to the CI prior to start of work. The CI should also be given the opportunity to review and discuss plans/specifications with the COR in the Engineering Office. Clarifications, errors and other questions should be discussed and solutions determined before construction starts.
- B. The CI must be thoroughly familiar with projects plans, specifications and materials/construction methods to be used. To perform effectively, the CI must also be familiar with other contract documents, especially the Contract General Provisions, Supplemental Provisions and Contract General requirements (sometimes titled “Special Conditions”). Do not assume that any documents remain unchanged and are applicable from one job to the next. Any questions concerning contract documents should be referred to the COR.
- C. After becoming acquainted with the project specifications, the CI should make a visual inspection by walking the site with station personnel and making frequent references to site and location drawings. Unusual terrain and other conditions that differ from the drawings should be noted and the COR notified. This allows for correction prior to the Contractor’s start of work. Notations should be made in daily construction reports and Daily Logs to provide background information in the event of future claims or disputes.
- D. When preliminary work is done in a thorough manner, inspections can be performed with confidence and efficiency.

1.6 Value Engineering

Each construction contract over \$100,000 must contain a mandatory Value Engineering clause giving an incentive to the Construction Contractor to submit Value Engineering Change Proposals (VECPs) to the COR (FAR 48.202). VECPs must be approved or rejected by the CO within 45 days of receipt. If the proposal has merit and is approved by the Service, the cost savings are computed, and approval for the proposed change(s) is issued to the Contractor by the CO in the form of a contract modification. The Service (as directed by the CO) may share cost savings with the construction Contractor in accordance with Section 48.104 of the Federal Acquisition Regulations.

1.7 Barrier-free Accessibility

The Americans with Disabilities Act (ADA) of 1990 prohibits discrimination against the disabled regarding accessibility of public facilities and programs. This Act also extends

coverage of Section 504 of the Rehabilitation Act of 1973 for accessibility of buildings

and facilities. Applicable standards are the Uniform Federal Accessibility Standards (UFAS) in accordance with the Architectural Barriers Act of 1968, Section 504 and the ADA. The CI should be familiar with these standards and particularly aware of any contract requirements for barrier-free accessibility to the disabled.

2.0 FIELD ADMINISTRATION

2.1 General

Construction Inspectors must perform administrative duties as well as technical inspection. Both aspects are important to a successful project. In short, administrative duties consist of informing the Engineering Office of the project status and preparing progress reports and daily logs for documentation for use in resolving claims or disputes. Field administrative work normally includes preparation or checking of the following:

- A. Inspector's Daily Logs
- B. Project Log Book (Field Diaries)
- C. Photographs labeled and dated for record purposes
- D. Construction Progress Payments
- E. Files (Filing and disposition)
- F. Safety and Accident Reports
- G. Punch (Deficiency) Lists
- H. Contractor Technical Submittals
- I. Contract Modifications
- J. Contractor's Required Notices (Posting and Maintenance)
- K. Special Reports
- L. Completion Report
- M. Final Acceptance report

2.2 Inspector's Daily Logs

This report is used more than any other as a record of the job status. It is the basic reference for preparation of the CO's Final Decision on disputes. Therefore, it must be accurate, complete and concise. This is effectively done by taking notes as you make inspection rounds.

Preparation of Daily Logs (see Exhibit 7.1):

- A. Log Sequence Number: The log number should be numerically sequenced from the first date of work as set by the CO's Notice to Proceed. There should be a log entry for each day of on site inspection from Notice to Proceed to final acceptance including days on which no work is performed.
- B. Station: name of station where the project is located.
- C. Date: Date for which log is written.
- D. Project: Title of contract.

E. Contract Number: Number of contract inspected. (Note: If there is more than one contract at a station, use one report for each contract number. Do not report two or more contracts on same log.).

F. Weather: Report general weather conditions for the day. (Example: cloud cover, temperature, precipitation and wind.).

G. Personnel Working:

<u>Contractor (or Sub-)</u>	<u>Foreman</u>	<u>Mechanic</u>	<u>Laborer</u>
ABC Const.		1	1
ABC Const.	1		2
XYZ Const.	1	1	2
XYZ Const.			2
DEF Const.	1	1	2

H. Work Performed: (Concisely note work performed including locations.)

1. Carpenter-Installed shoring on 40 linear feet of ditch north of office.
2. Backhoe Operator-Excavated 40 linear feet of ditch, (0+00-0+40), encountered rock bottom 18 inches from station (0+10 to 0+15).
3. Electricians-Installed 30 linear feet 3-inch PVC conduit and 2 pull boxes in SW corner of building.

I. Remarks: (record events/conditions that could have a bearing on possible claims or disputes)

1. Backhoe arrived at 8:45 a.m.
2. 200 l.f. of 3-inch conduit (type) received.
3. Mr. Jones, Region 5 Refuge Office, arrived at 11:00 a.m., left at 2 p.m. (Include comments by Mr. Jones)
4. Discussed contract clause on rock excavation with Superintendent and Project Manager.

J. Signature (Inspector): Self-explanatory.

K. Signature (Contractor): The Contractor's Superintendent should sign all reports. For purposes of acknowledging receipt only, the Contractor has the right to object to anything in the report. If there are any objections, they should be transmitted by the Contractor to the CO on the Daily Log.

2-2

L. The Daily Logs should be forwarded to the COR and the CO on a weekly

basis.

2.3 **Project Log Book (Field Diaries - Optional Procedures)**

Separate projects log books (Field Diaries) for each project can be maintained on site during construction in the standard size cloth-bound books provided. This log is for Service use only and should be confidential, unless released by the CO. However, this does not preclude transfer of certain information from the Diary to Daily Logs. The Diary should contain everything that is to go into the Daily Log, but not take the place of the Daily Log. This can be invaluable with respect to Contractor's claims, since it often gives information you might hesitate to include in your Daily Log. The Diary should be completed as follows:

- A. Enter the project name and number, prime Contractor/Subcontractors; names and addresses; and book number inside of the front cover.

When the book is filled or project is completed, print the project name/number and book number on the outside center portion of binder. The book number should be at the top.

- B. Number each page consecutively in upper right hand corner.
- C. Notes should be recorded for each day that work is performed. There should be no blank pages. If no work is performed on regular work day, so state, and give reason.
- D. Date and sign each daily entry. If a page is used for more than one day, each day's notation should be dated and signed under notation. Place date above notation and signatures below. If more than one page is used for a day, date and sign each page.
- E. Pages should not be torn from the book. If a notation or page is to be voided, write "Void" through notation or across entire page. These books may be used in Board of Contract Appeal hearings and must be complete.
- F. If the project is completed before the book is completely filled, insert on the page following the last entry: "Project completed on: date. End of Log for this Project." If the book is filled but project is not completed, use last page to state, "End of : Book Number, Log continued in: Book Number." Date and sign page.
- G. All Diaries should be forwarded to the COR upon completion of project. Do not forward individual books until project is complete, unless requested.

2-3

- H. Following are the primary items that should be entered:

1. Type, size and make of equipment should be listed, showing date of arrival and its condition. Also, the date equipment is removed from project site.
2. Weather conditions, including any effect on work.
3. Instructions, oral or written issued to Contractor's Superintendent, including any disputes or misunderstandings.
4. List name(s) of visitors and where from.
5. Note trips made and purpose relative to project, (e.g., visited ready-mix concrete plant at ____ for purpose of ____).
6. Briefly note official telephone calls and purpose.
7. Record details pertinent to unusual condition or delaying factors encountered.
8. Quality and location of concrete placed.
9. Comments relative to unsatisfactory work – note whether or not corrections were made. When work is corrected, note in Diary.
10. Note photos taken and what photos show.
11. Summarize conferences held relative to project.
12. Note receipt of materials.
13. Record accidents, fires, etc.
14. Items of work started or completed (e.g., earthwork for buildings, placing forms, placing steel, etc.).
15. Materials rejected and removed from job site.
16. Violation of field station regulations by the Contractor's personnel or material suppliers.

2.4 Photographs and Videotape for Record Purposes

Photographs and/or videotapes play an important role in both inspection and contract administration. They show progress of work and may be used if needed in appeal proceedings. Photographs are a key part of inspection/reporting and must be labeled and dated. The use of videotape may be particularly appropriate in some situations (providing specific views and details with audio description). Progress photographs should be made of each major phase of work including, but not limited to:

- A. Construction site before work starts including possible controversial areas.
- B. Grading and trenching, oxidation ponds, roads, etc.
- C. Foundation and footing excavation.
- D. Concrete forming, rebar placement, placement/finishing of concrete.
- E. Door/window framing.
- F. Interior and exterior finishing.
- G. Specific items of unsatisfactory work.
- H. Construction equipment (e.g., material hoists, backhoes, dozer, loaders).
- I. Differing site conditions revealed as work progresses.
- J. Each photo should contain the following information on back (or numbered and accompanied by a list containing this information):
 - 1. Name and number of project.
 - 2. Date of photograph.
 - 3. Brief description of building(s) or facilities identified (use same numbers/names as on contract drawings).
 - 4. Purpose of photograph.
 - 5. Direction camera is facing and where it is located.
 - 6. Signature.
(Photo negatives should be kept with project files.)

- A. The CI must maintain a complete set of files on-site during construction for each project. Correspondence should be filed chronologically. Files should be subdivided into sections as follows:
1. Contract (including plans/specifications)
 2. Correspondence
 3. Payments
 4. Change Modifications
 5. Daily Logs - Daily Diaries
 6. Telephone Logs
 7. Submittals/Shop Drawings/Samples (filed in sequence of contract specification divisions)
- B. Prior to the project's final inspection, the CI should scan all files and remove irrelevant material. The COR should review the material removed and approve its disposal. Remaining files must be turned over to the station manager.

2.6 Special Reports

A. Suspension of Work Orders

Suspension of Work orders are issued by the CO in cases of safety violations, extreme weather conditions, deviation from specifications, or differing site conditions, etc. A complete record must be made of work accomplished to date on the portions of the project affected by the Suspension of Work. Use photos as needed and submit a complete report on status of affected construction to the COR. A list of all equipment on the project title during the work stoppage and how it was affected must be reported (e.g., one D7 Caterpillar Tractor and 8 cu.yd. Scraper on project idle due to Suspension of Work on (date). Also, list all of Contractor's personnel affected by the Suspension of Work. A list of material presently on site to be incorporated in affected work must also be reported.

B. Differing Site Conditions

Notify the COR or the CO immediately by telephone when a Differing Site Condition is encountered. This condition is defined as any subsurface or latent physical condition differing materially from those indicated in the contract or an unknown physical condition of an unusual nature differing materially from those ordinarily encountered in work of the type to be performed in the contract. Examples are excessive ground water; hidden rock formations; unsuitable foundation material; abandoned foundations; and utility lines not shown.

Document by memorandum all available information that may be pertinent to any possible change in the contract price or time. Include any feasible change in design, relocation or other corrective measures. The Differing Site Condition clause of the FAR states that the Contractor must notify the CO immediately, in writing, and the CO shall investigate the condition immediately. However, the Contractor might not provide written notification. It has been ruled by the Department of the Interior Board of Contract Appeals that if the Government (COR/CI) is aware of, or should have been aware of, the Differing Site Condition, then that fact constitutes notice to the CO and the Contractor need not provide the written notification.

The importance of proper reporting cannot be overemphasized and is applicable to any Differing Site Condition. When necessary, the COR and CO should visit the site as soon as possible. Sufficient photographs of existing conditions and equipment used must be taken and submitted with complete description of the work and area(s) involved. Information on make/size model/age of equipment used should be recorded. Any special supplies required should also be recorded. The COR will normally advise of specific information required. In general, the following information should be forwarded to the COR:

1. Existing conditions including elevations if necessary to determine quantity of material, and final elevations necessary to correct condition.
2. Dimensions of excavation to determine work performed.
3. Record of all labor (by craft), material and equipment used in connection with any additional work authorized. (Reference the record on the Inspector's Time and Materials form, Exhibit 7.5.).

The purpose of this report is to compile a complete, accurate information to permit a fair and reasonable estimate of actual cost of work performed by the Contractor in connection with any Differing Site Condition. If the Contractor's operation is inefficient, it should be reported by documenting reasons. The Contractor's actual cost may or may not be used to determine an equitable adjustment. If the

Contractor's operation is costly due to: inefficiency, lack of equipment, or use of wrong type/size of equipment, or due to procedures or methods, this should be documented in logs and in a memorandum to the COR. The Contractor should not, normally, proceed with work that will be affected by the Differing Site Conditions until instructed to do so by the CO.

C. Other Special Reports

The Inspector should furnish special reports, other than Differing Site Conditions, when necessary or requested by the COR. Special reports may include factual data on delays or changes that involve contract time and cost. Special reports are required for alleged labor violations such as failure to pay overtime, misclassification, wages rates, etc. Other items requiring special reports include structural failures, job-related accidents, damage to completed work, and the Contractor's failure to perform work in accordance with specifications.

2.7 Substantial Completion Reports (Beneficial Occupancy)

The decision to accept a project as substantially complete or for beneficial occupancy may be made only by the CO. Forward requests to occupy or use a facility prior to its final acceptance date to the COR immediately for further instructions. If a decision is made to accept a project prior to final completion, the CI will notified and requested to submit to the COR a complete list of those items of work remaining.

2.8 Final Inspection Report

Final inspection and reporting are of such importance that a separate chapter (Chapter 5) is devoted entirely to this subject.

2.9 Final Acceptance Memorandum

When all work has been completed, the COR will transmit a memorandum to the CO indicating compliance with project specification and recommending a date for final acceptance.

2.10 Safety Reports

The subject of safety reporting is covered separately in Chapter 4 of this Handbook.

2.11 As-Built Drawings

The Contractor is required to maintain one set of plans and specifications at the project site for the specific purpose of recording changes and additions to reflect “as-built” construction. The CI should carefully review these plans periodically (at least monthly) in conjunction with payment requests to see that all changes and additions have been documented including appropriate sizes, dimensions, elevations, locations, materials, etc.

The CI should record the “as-built” construction, as well as existing conditions encountered (e.g., existing pipelines), for a complete record. In this way, the CI can check the accuracy of the Contractor’s as-built drawings.

2.12 Payment to Contractor

- A. Format: The Contractor must use a format for progress payments that is acceptable to the CO.
- B. Procedures: The Contractor should submit a request for a monthly progress payment to the CI for concurrence. The CI must review the payment request for correctness as the percent/quantity of work completed. Upon agreement, the CI will sign the request and return it to the Contractor. It is the sole responsibility of the Contractor to forward the signed request to the COR for processing and submittal to the CO for approval of payment.

3.0 **TECHNICAL INSPECTION**

3.1 **General**

The technical inspection of the project and its findings usually determine administrative activities in which the Inspector will be engaged. Effective inspection and good end products are accomplished by familiarity with contract plans and specifications and relevant contract documents; knowledge of the project work phases; and a good working relationship with the Contractor's personnel.

The following instructions will serve as a guide to the Inspector in the performance of the job, as do other related manuals, and technical information. This Handbook is to refresh your memory and to point out potential sources of trouble. It does not, however, replace plans/specifications, experience, training, and common sense, with which to obtain high quality construction. When a difference exists between the contract specifications or documents and this Handbook or applicable manuals, the contract requirements should be enforced. If you have any questions about this guide or the contract specifications, consult the Construction Manager. This Handbook does not cover every situation, but does address those found most frequently in the Service's construction projects.

During inspections, certain basic tools and inspection aids are often required for accurate measurement data. Following are those most frequently used, but this is not all-inclusive as specialized inspections may require additional equipment: 25 ft. tape, 6 ft. folding rule, engineer/architect scale, lock level, magnet, high-low thermometer, standard volt-ammeter and camera (for photo records).

Note: The following technical inspection sections in this chapter are presented in the approximate sequence as in the Construction Specifications Institute (CSI) document for construction standards. For reference purposes, the CSI Division number is in parentheses next to the section title.

3.2 **Earthwork, Trenching, Site and Finish Grading** (CSI Division 2)

A. **General**

Earthwork generally moves rapidly and sometimes highly skilled engineers or layout men are not employed by Contractors. Thus, the Inspector must check controlling elevations at or before the start of work and periodically during progress. Hand levels are usually sufficiently accurate for checking purposes. When more accuracy is needed or there is doubt as to the Contractor's accuracy, checking should be done with an engineers (builders) level.

No changes will be made in any grades which are shown on the contract drawings without prior approval of the Construction Manager.

B. Protection of Existing Utilities

The Inspector should check with station maintenance personnel to determine the location of underground utilities of all types (some may not be shown on contract drawings). Any utilities not indicated on the drawings must be documented and transmitted to the Construction Manager. If underground utilities are damaged by the Contractor, it is expected that the Contractor will provide permanent repairs. The Inspector must maintain accurate records of work for use by the Contracting Officer in the event of a claim for reimbursement.

C. Inspection of Foundation Materials

The Inspector must check the excavation to determine if foundation material is suitable (free of organic or frozen material, debris or standing water), and whether rock has been encountered. If rock or unsuitable material is present, it must be immediately brought to the attention of the Construction Manager who should visit the site and issue further instructions for continuing work.

D. Placement of Foundation Materials

Backfill under footings of buildings will not be permitted unless otherwise specified and any over-excavation should be filled with an approved compacted backfill or concrete. Suitable foundation material for over-excavation is the responsibility of the Contractor.

E. Backfill

Backfill material used under concrete slabs should be carefully inspected. The material must be free of organic and frozen material and debris. The material should be of a type that is readily compactable (certain cases will require that it be free-draining). The material, before compaction, must be placed in accordance with contract requirements. It should be brought to specified moisture and density with mechanical compaction equipment. Density and lift thickness should be verified by a testing laboratory or a qualified inspector. Failure by the Contractor to obtain adequate compaction frequently causes unsatisfactory conditions and considerable corrective work. The flooding of an area in lieu of mechanical compaction is normally not permitted by the specifications. Any questions concerning suitability of the material or requirements of compaction testing should be brought to the attention of the Contractor and the Construction Manager if necessary.

Additional compaction and retesting should be requested as needed.

F. Drainage Fill

Fill material, normally gravel or crushed rock, requires careful selection and compaction as described in contract specifications.

G. Rock Excavation

If rock is encountered, footings may require redesign especially in the case of building foundations or pipeline excavation, in lieu of excavating the rock. Therefore, it is important that the Inspector notify the Construction Manager immediately.

H. Finished Grades

Finished grades at building lines should provide for positive drainage away from building walls unless otherwise specified. Drainage trenches designed to carry water should be uniformly graded to their lowest point of discharge. Finished site grading tolerances are usually specified to eliminate water ponding. Final site grading should be verified before allowing topsoil or pavement operations to proceed.

I. Trench Excavation and Backfill

All trenching activities must strictly adhere to OSHA regulations. Excavation and backfill should only be conducted using approved methods and equipment by qualified operators. Open excavations over 4 feet in depth may require the use of approved trench boxes or shoring depending on slope, soil type, environmental conditions and application of surcharge loads. Open excavations will be barricaded or posted whenever work is suspended regardless of the time period. Backfill for all excavations should be of the types specified and placed in specified thicknesses and compacted to the densities and moisture contents specified. Usually an independent testing laboratory is required to conduct the density testing on backfill material. The Inspector should monitor testing for compliance with applicable American Society of Testing Materials (ASTM) procedures and should require recompaction and retesting of areas that do not meet density requirements. Compaction within 18" of any structure should be conducted using hand operated whackers or vibraplates. Do not allow the use of heavy rollers or other heavy equipment type compactors within 18" of structures or as required by specifications.

3.3 Soil Treatment for Termites (CSI Division 2)

The Inspector should verify that both the applicator's qualifications and materials have been approved. Mixing of materials and rate of application should be checked periodically to determine that both comply with requirements of the specifications. The Inspector should ensure that organic matter and debris in areas to be treated have been removed prior to application of chemicals.

3.4 Utilities (CSI Division 2)

A. General

Prior to start of construction, plans and specifications should be thoroughly reviewed for location of existing utilities to avoid damage to existing systems. Lines and grades should be established and staked before any excavation or utility operations begin. Check each system for conflicts at each point of crossing. Check planned connections to existing utilities. Interruptions of utility service must be coordinated with station personnel. Check the line and grade of trenches before laying pipe and after completion of each section. For most types of pipe, manufacturers have specified installation instructions which should be used. If there is any difference between these instructions and contract specifications, notify the Construction Manager.

B. Water Lines

- (1) All piping should be laid straight between changes in alignment or direction and at uniform grade as indicated on the contract drawings and specifications.
- (2) All piping should be kept free of excavated material or other foreign substances.
- (3) Pipe should be cut straight and true leaving a smooth right angle cut.
- (4) Pipe should be laid using a laser instrument or other approved method ensuring compliance with contract invert requirements.
- (5) Thrust blocks placed behind tees, bends and hydrants must be centered so that the thrust of water pressure will be exerted against the center of the block. A bond breaker (tarpaper or polyethylene) should be placed between the pipe fitting and concrete.

(6) Pressure or leak tests should be performed before allowing backfill placement over pipe joints or fittings. Testing requirements vary with the type of pipe and its intended purpose. Contract specifications usually detail the method of testing.

(7) Potable water distribution lines require sterilization as outlined by contract specifications. Generally the line is flushed with clean water to remove any mud or debris that may be in the pipe. The line's volume is calculated and a chemical disinfectant is introduced into the line and retained for a designated period of time. The line is again flushed with clean water until its discharge shows no further signs of the chemical disinfectant. Usually water samples are taken and analyzed by an independent testing lab.

C. Drain Lines

(1) Drain line construction should always begin at the farthest downstream manhole and proceed upstream or "uphill." For bell and spigot pipe, the bell end of pipe is usually required to point upstream. Check specifications to verify installation requirements.

(2) Before placing the drain into service, lengths between manholes should be lamped (or inspected using laser instruments), particularly if there is a question concerning bedding or backfilling of a particular length. The most convenient method is for a strong light to be placed in the downstream manhole and pointed into the upstream line. The observer, with a mirror, then should check alignment in the upstream manhole.

(3) When infiltration tests are required, the ends of lines to be checked should be plugged in the upstream manholes and weirs placed in the downstream manhole. Infiltration should not exceed the amount specified. The weir must be cut to the shape of the manhole channel and caulked in place to prevent leakage.

(4) When exfiltration tests are required, refer to specification procedures.

3.5 Concrete (CSI Division 3)

A. General

This section covers commonly encountered concrete work. Specialized procedures are covered in subsequent sections. Inspectors are cautioned that contract requirements for preparation of the subgrade concrete placement for a given job are contained in drawings and

specifications prepared for that contract. Also, contract requirements often change from job to job. This Handbook should, therefore, be used in conjunction with careful reading of the specifications.

B Materials

Before concrete work starts, check to verify that all materials and mix designs have been approved.

C Tests

Project specifications generally require the Contractor to furnish an Independent Testing Laboratory to make all required tests. Tests generally required are slump; air content; temperature; and curing and testing of test cylinders. Verify that the tests required by the contract are being performed, including number, curing time and frequency. If the specifications require the Government to take all tests, then the Inspector should be familiar with correct procedures for all tests and that all required equipment is available prior to starting any concrete work.

The specifications will generally list the water to cement ratio (w/c). The Contractor may request to add water at the site. The request can be approved provided the w/c ratio or allowable slump is not exceeded. Prior to approving the request, the delivery tickets should be checked and a new w/c ratio determined. If the w/c ratio or slump is exceeded, the load should be rejected and the Contractor notified. The Daily Log should state the basis for rejection.

D. Delivery/Load Tickets

The concrete manufacturer should provide a delivery/load ticket to the Contractor. A copy of the ticket should be furnished to the Inspector by the Contractor before unloading the concrete at the site. The ticket should contain the following information:

- (1) Name of batch plant
- (2) Serial number of ticket
- (3) Date
- (4) Vehicle/license number
- (5) Name of purchaser/contractor
- (6) Job location/name
- (7) Specific class of the concrete in conformance with that specified and approved
- (8) Amount of concrete (cubic yards)

- (9) Time loaded weights and types of ingredients
(cement/aggregate/water)
- (10) Type, names and amounts of admixtures
- (11) Additional information required by purchaser
- (12) Revolution counter reading at first addition of water
- (13) Amount of water added at site
- (14) Indication that all ingredients are as previously certified.

E. Forms

The forms should be constructed from materials specified and to the shape, form, line and grades required. They must be sufficiently braced to prevent deformation under load. Forms should also be constructed so as to prevent any leaks at the joints (i.e., mortar leaks, not minor seepage of small amounts of free water). Checking of forms for line, grade and stability is a duty of the Inspector. Forms are often constructed in panels for multiple use purposes. Forms should be coated with approved form oil or equal. After each use, forms should be thoroughly cleaned and checked for holes or roughness which must be repaired prior to reusing. Careful checking of the forms will often eliminate unsightly finish work. Twisted, warped, or otherwise defective forms should be removed from the site and not used until repaired.

F. Joints

All joints (expansion, contraction, construction) should be located as shown on contract drawings or otherwise approved. If the location of joints do not appear on drawings, check with the Construction Manager for appropriate locations. Verify that water stops are firmly secured in correct location, undamaged and spliced properly.

G. Embedded Items

Prior to start of concrete placement, the Inspector should check the forms to verify that all the embedded items are in place (includes inserts, reinforcing steel and all other embedded items shown on drawings). This inspection should ensure that reinforcing steel is of the size and shape specified, and that it is clean and properly supported to remain in place during the placement. Supports should be accurately placed and reinforcing securely tied at intersections. For concrete slabs on grade and footings, the bar or mesh reinforcing should be supported on precast concrete blocks or chairs of approved type spaced at intervals required by the size of the reinforcement used. Reinforcing should be kept to the height specified above the underside of the slab or subgrade.

H. Conveying and Placing

Concrete should be placed in a continuous manner, and as rapidly as practical to avoid cold joints, until the unit is completed. Concrete that has obtained its initial set, or has contained its water content for more than the allotted time, must not be deposited. Concrete must not be dropped freely more than the specified distance and should be conveyed from the mixer to the place of final deposit by a method that will prevent the segregation or loss of the materials. Concrete should be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Placement should be conducted at such a rate that concrete is at all times plastic and flows readily into space between reinforcing bars.

Concrete placed in forms should be in layers not more than the specified depth and each layer should be consolidated with the aid of vibrating equipment supplemented by hand-spading, rodding, or tamping. Vibrators should in no case be used to transport concrete inside the forms. At least one spare vibrator should be maintained on the project at all times as a replacement. The duration of vibration should be limited to that necessary to produce satisfactory consolidation without causing segregation. A sufficient number of vibrators should be available to consolidate the concrete as required in accordance with the amount placed, so that no concrete will stand in the forms for more than 10 minutes before it is vibrated. Vibrators will not be placed between forms and the outer row of reinforcing. Vibrators should not ordinarily be permitted to touch forms.

I. Removal of Forms

In no case should forms or shoring be removed until the concrete members have acquired sufficient strength to safely support their weight and the load thereon.

J. Finishing

Finishing must be by the method specified. Repair of defective areas and removal of fins, form marks and holes are required immediately upon removal of forms. Check surfaces for specified smoothness tolerances. Require rough areas and high spots to be ground smooth.

K. Curing and Protection

Concrete must be maintained in a moist condition for the specified duration. Generally, several methods of curing are permitted by the specifications. The importance of curing cannot be overstressed.

Proper curing has a critical effect on strength and appearance of the concrete. Curing must, therefore, be properly controlled and inspected. Freshly placed concrete should be inspected several times daily to ensure proper curing. Any small tears or openings in curing paper or polyethylene film must be covered with another piece of paper immediately to prevent loss of water by evaporation, particularly in arid areas (liquid membrane may be specified for the curing process). Fresh concrete must be protected from all damage including rain, too rapid drying, freezing, premature loading and subsequent operations that might affect its strength during the curing period.

L. Cold and Hot Weather Concreting

Cold weather concreting shall be accomplished within the American Concrete Institute (ACI) limits of ACI-306 and hot weather concreting shall be accomplished within the limits of ACI-305. (These ACI standards are available from the Engineering Office.) The Inspector should be familiar with these requirements and refer questions to the Construction Manager if needed.

M. Backfilling and Loading

Do not allow backfilling or have additional construction placed upon fresh concrete for at least 7 days after placement or as specified. Most concrete has reached approximately 80% of its designed strength within 7 days.

3.6 Lightweight Concrete (CSI Division 3)

Proportioning, mixing and placing of lightweight concrete should be in strict compliance with supplier's directions to produce homogeneous concrete having characteristics set forth in the specifications. Review the Contractor's submittal for lightweight concrete.

The surface of finished lightweight concrete should be adequately protected from damage by heat, cold, rain, snow, direct rays of sun, and wind; and should be cured and allowed to dry suitably for installing the roofing material (or slabs on metal pans) specified; and should be maintained in such condition until the roofing slabs have been installed.

Test specimens should be made as required by specifications. Do not hesitate to require tests if there is any doubt as to compliance with contract requirements or the manufacturer's recommendations.

NOTE: For roller compacted concrete (RCC) or soil cement base course construction, you should check with the Construction Manager for appropriate inspection guidance. Such specialized concrete work requires skilled supervision and experienced operators to meet contract requirements.

3.7 **Stucco (CSI Division 9)**

F. General

Stucco is the term applied to exterior plastering. Generally, stucco is applied in three coats: scratch coat, brown coat and thin finish coat.

B. Inspection of Materials

Only one brand of material should be used throughout a single structure. If more than one brand of material is used, considerable difference in finished colors and texture can result. Fiber and hair should be free of dust and dirt. Each fiber or hair serves as a minute bit of reinforcing. If dust or dirt is present, mortar will not adhere properly to the fiber or hair. Proper grading of the sand, as required by specifications, is critical. For finished coats, it may be necessary to use a somewhat finer aggregate, however, excessive fineness is one of the principal causes of cracking and crazing.

C. Installation of Reinforcement

Metal reinforcement must be straight, without buckles and with staggered joints, thus preventing weak points for a crack to follow. The long dimension of metal reinforcing must be across the supports, to remove most of the sag. Reinforcement applied to wood supports should be attached with nails or staples driven through furring sleeves (spacer) to provide space for mechanical key behind the reinforcing. Expanding metal lath mounted on vertical supports should be placed with the middle web sloping in towards the vertical supports, causing the stucco to slide in and form a good key.

D. Mix

Cement and aggregate for each batch of stucco should be accurately measured, thus assuring overall uniformity.

(1) No water should be added to the cement and aggregate until they are thoroughly dry mixed, thus ensuring against lumps of cement and overly sandy spots in stucco.

(2) Proper cleaning of the mechanical mixer, mixing boxes and tools after each batch is important. This prevents the use of stucco which has already started taking its initial set. Retempering should not be permitted. Proportions are generally well defined in specifications and must be adhered to.

E. Application of Stucco

(1) Surface to receive stucco must be clean, free from dust, dirt, etc. Any foreign particles on the surface will interfere with the bond.

(2) Masonry surfaces to receive stucco must be uniformly dampened, thus preventing masonry from sucking moisture out of the stucco too fast, yet giving a uniform suction.

(3) The scratch coat should be applied with sufficient pressure to form good keying.

(4) Just before the scratch coat has set, it must be well scratched to provide bond for the brown coat.

(5) The scratch coat should be damp cured as stated in specifications.

(6) Before application of the brown coat, the surface should be evenly dampened with fog spray to obtain uniform suction. The interval between the brown coat and the finish coat should be per specifications.

(7) The brown coat should be dampened thoroughly and evenly before applying the finish coat. Use of a brush for dampening should not be permitted.

(8) Stucco should not be applied when the ambient temperature is below 40 degree Fahrenheit. Stucco which is frozen and thawed will not cure properly.

F. Curing

(1) Stucco must be cured properly. to develop maximum strength and density. This can best be done by moistening each coat as soon as the stucco has hardened sufficiently to prevent any damage from applying water in a fine fog spray.

(2) As soon as the finished coat has taken its initial set, stucco should be protected from direct rays of the sun, and curing process should be

started. The stucco should be kept moist by spraying at intervals for the period required by specifications.

- (3) Do not use membrane-curing compound for curing stucco.

3.8 Masonry (CSI Division 4)

A. General

This section covers brick, concrete block, cinder block, glass block, tile, stone and other masonry construction.

B. Samples

Samples of all material should be submitted for approval as required by specifications. Verify that required sample panels have been erected and panels are close enough for comparison purposes. Check masonry against sample panels. The materials, workmanship and finished appearance must be the same.

C. Tests

Verify that all tests required by the contract have been performed and test results submitted. Daily and/or lot tests must be performed as required.

D. Materials

Materials on site must match the approved samples for color, texture and grade. Sizes and defects must be within permissible tolerances. Verify that mortar materials delivered to the site are as specified, tested and approved.

E. Installation

Ambient temperatures must be at or above the minimum temperature specified. Check masonry dimensions against existing foundations and structural framing. Any discrepancies should be brought to the attention of the Construction Manager. Check for conflicts between openings and partitions or equipment locations. Control joints should be located at joints of openings rather than a couple of feet away from openings. Ensure that joint reinforcement does not pass through control joints. Be sure that courses are installed level and plumb. Masons should wait for initial set of mortar before tooling joints. All tooling must be completed before quitting work for the day. If units are moved after

mortar takes initial set, remove and replace them, using fresh mortar. Excess mortar should be removed from faces of units and joints before setting up.

3.9 **Structural Steel** (CSI Division 5)

A. General

- (1) Structural steel is defined as the steel that supports the structure.
- (2) Reinforcing bars used in concrete are not considered structural steel; neither are metal siding, roofing, or miscellaneous items, such as metal windows, stair railings pressed steel door frames, and metal trim.

B. Shop Drawings

- (1) Shop drawings for all of the structural steel are to be provided by, the Contractor or fabricator. The Contractor is responsible for errors in fabrication of steel and all mismatched, or otherwise improperly prepared material. Such material should be replaced or corrected.
- (2) Shop drawings, for large or complicated assemblies, are usually supplemented by erection drawings to indicate where each piece of fabricated steel is to be placed in the structure, and to provide information on end markings that pieces may be assembled correctly.
- (3) The Inspector should make frequent reference to shop and/or erection drawings, but should not set aside the contract drawings since they are the basic requirements, regardless of approval of other drawings. All discrepancies between the two should be investigated and reported.

C. Inspection of Materials

Structural steel should be checked for the following items prior to erection:

- (1) **Size/Shape.** Check each member against the shop drawings for correct size, shape and weight. Check sizes and type of bolts, rivets, washers and welds as well as hole diameters and location. Check for beams made up of welded plates being substituted for a rolled beam.
- (2) **Alignment and Damage.** Members must be free of kinks, bends or other distortions. No straightening of bent or misaligned members should be allowed in the field except as approved by the Construction Manager.

(3) New Steel. Verify that the steel furnished is new and has not been reworked or fixed. Verify that furnished steel is of domestic origin and not of foreign manufacture. Steel must also have been properly stored and free of rust.

D. Installation

Setting of base plates should be observed and results checked. Base plates should be accurately located, as their position will affect the remaining steel work. The levelness of the plates should be checked with a reliable spirit level prior to grouting. Grouting operations should be observed. Grouting should fully cover the underside of the plate and should be packed in the area in a dry consistency.

The frame must be plumbed and properly guyed before making final adjustments to setting. Verify that all steel members are accurately fitted, leveled, and guyed before permanent connections are completed.

NOTE: Rivets have, in nearly all cases, been replaced by structural steel bolts, but where rivets are still used the following paragraph applies:

Imperfect or loose rivets should be marked for removal. Check the method of removal to ascertain that no damage results to the piece or the rivet hole. Loose rivets can be detected by a solid tap of a light hammer. The sound of a loose rivet will be dull, or a movement of the opposite head can be detected. Overly tight rivets, resulting from excess driving, can be detected by the high rivet material or by the high pitch of the ring when tapped with a hammer. Rivets which are too tight may also be formed if the rivet is overheated. Stress in overheated rivets may become excessive when the load is added to the high initial tension, therefore, they should be replaced.

Verify that all welds called for on approved shop drawings have actually been made, and are accurately located and of specified sizes. Verify that all bolts, heads and nuts are resting squarely against the metal and that all bolts have been drawn tight. Structural bolts must be of domestic origin.

E. Painting

- (1) Inspect shop coat for brazed areas or for areas not to be painted.
- (2) Check specifications to determine if contact surfaces for joints to be connected with high tensile bolts should be painted or not.

(3) Steel, both painted and unpainted, should be examined for loose mill scale or rust.

(4) Abraded spots or other damage to the shop coat should be touched up with specified paint.

F. Storage and Handling

(1) Steel should be stored in one location, neatly off the travelway, and not scattered over the site.

(2) Steel members should be blocked off the ground to avoid corrosion and to aid inspection. For prolonged storage, the steel must be properly protected against the elements.

(3) When unloading or during erection of long flexible steel members or trusses, the Contractor should use a double choker or a double sling so as not to overstress the member by picking it up at only one point.

(4) Steel should be handled in a manner to prevent distortion or damage.

3.10 **Steel Doors and Frames** (CSI Division 8)

A. General

Specifications require that shop drawings be submitted on all steel doors and frames. The Inspector should receive approved shop drawings prior to installation of metal doors and frames. Check the doors and frames against the shop drawings in detail, including the thickness of metal, all other features that affect the strength of the door such as: construction details, method of assembling sections, location and installation of hardware, the size, shape and thickness of all specified materials, joints and connections. The finished surfaces should be checked against the specification requirements.

B. Field Measurements

The Contractor should verify all measurements at the building site and be responsible for dimensions, fittings and the proper attachment of items directly connected to the door installation.

C. Erection

The doors and frames should be erected in accordance with the details

contained on the shop drawings and on the contract drawings. Prior to erection, hardware, weatherstripping and louvers should be checked to determine compliance with shop drawings, contract drawings and specifications. Verify whether or not door frames must be grouted. Verify that frames are properly supported in masonry walls and that installed doors swing freely.

3.11 **Roofing (Membrane, Ballasted and Glued)** (CSI Division 7)

A. Inspection of Materials

(1) Project specifications describe the method of application, quality of material and use of manufacturer's recommendations. Generally, approved submittals and details supersede the specifications as each manufacturer has specific details to maintain warranty. These requirements must be followed without deviation. Periodic inspection by the manufacturer may be required during installation and usually is required upon job completion to comply with warranty.

(2) Upon delivery of roof insulation, membrane deck sheathing, vapor retarders, flashing, ballast and sealants to the job site, determine immediately that the material is as approved for the project. Materials should be stacked and stored to prevent damage and afford protection from the weather.

B. Inspection of Installations

(1) No inspection of subsurface and roofing should be undertaken without full knowledge and understanding of specifications and details including those of the manufacturer.

(2) All projections, protruding nails, surface irregularities, holes, or surface voids must be corrected prior to application of roofing. Prior to application, all materials must be dry and free from moisture absorption.

(3) Verify locations of all penetrations and types of penetrations including conduits, and perimeter details for type, size and spacing of fasteners for nailers and membrane.

(4) Where cant strips are specified, they should be uniform and smooth.

(5) Verify that decking is supported and secure, all penetrations are solidly set and the roof is clean.

- (6) Do not apply roofing materials to damp, frozen, or dirty deck surfaces. Adhere to specified temperature requirements.
- (7) Assure that deck is not overloaded due to the weight of equipment and material during installation. Precautions should be taken to uniformly distribute materials on the deck and to roll out sheet goods promptly after delivery to the roof.
- (8) Tapered insulation, roofing boards and vapor barriers must be installed per manufacturer's instructions without wrinkles and buckles. Material should fit neatly at roof breaks, perimeter and protrusions through the roof.
- (9) Membrane roofing must be installed per the manufacturer's written instructions with special attention given to cleaning, overlaps, bubbles, wrinkles, end and edge joints.
- (10) Watertight penetrations and parapets must be sealed with approved flashing membrane material.
- (11) Ensure that water does not flow beneath completed sections of roof. Edges must be sealed when weather is threatening.
- (12) Traffic surfacing should be at locations indicated.
- (13) Approved ballast should be placed and distributed evenly to the thicknesses noted on drawings.
- (14) Avoid traffic on completed roofing.

3.12 **Asphalt Shingle Roofs** (CSI Division 7)

A. Inspection of Materials

- (1) The specifications describe the method of application, quality of materials, and quantity of materials or refer to manufacturers' recommendations. These requirements must be followed without deviation.
- (2) Ascertain from the plans and specifications those surfaces and the type of roofing to be installed on the individual buildings. Upon delivery to the job site, verify immediately that the materials are in accordance with previously approved samples.
- (3) All roofing material received should be protected to prevent damage during storage.

(4) All bonding material should be delivered to job site in sealed containers with the manufacturers' original labels.

B. Inspection of Installations

(1) All projections, protruding nails, surface irregularities, loose boards, and large cracks must be corrected prior to application of roof to prevent damage to shingles.

(2) Starter strips for mineral-surfaced, asphalt, strip-shingle roofing must project one-half inch beyond the eave line to form a drip. Check plans to determine if a drip strip is specified.

(3) Extreme care should be exercised in following the method of application of the roofing at valleys, hips, ridges, and flashing in order to secure water-tight areas.

(4) Minimum air temperature requirements for installing singles must be adhered to.

3.13 **Sheet Metal Roofing** (CSI Division 7)

A. General

(1) Sheet metal items covered by this section are installed primarily to prevent water from entering the building construction at joints, to carry water off, and to protect against the weather.

(2) Most items installed will be partially covered by other trades in the finished work. Therefore, inspection must be done when the items are exposed and can be observed. Items to be imbedded in concrete should be inspected at the time they are imbedded.

B. Inspection of Materials

(1) Specifications generally require samples of items for installation to be submitted for approval. Materials received at the job site should be inspected for conformance with the previously approved samples. Those materials which are fabricated should be checked with shop drawings, contract drawings, and/or specifications. Note that the required gage for non-ferrous sheet metal and ferrous (iron) sheet metal are of different thickness for the same gage; the proper measuring gage must be used.

(2) Screens for ventilation, as required, should be inspected upon delivery to job site for compliance with specifications requirements as to

3-18

mesh, type of material, and frame construction.

(3) Verify that the soldering flux intended for use on the work is as specified.

C. Dissimilar Materials

Evaluate the entire job to see that all dissimilar metal materials in contact, which may support galvanic action, have been isolated from each other. Typical examples to watch are:

- (1) Copper and aluminum flashings in contact with each other, or with ferrous (iron) material.
- (2) Copper and aluminum flashings nailed with ferrous nails.
- (3) Aluminum and ferrous equipment bases set on copper flashings.

Review the specification requirement for method of isolating dissimilar materials.

D. Inspection of Installations

- (1) Nails, screws, and bolts for installing and fastening sheet metal should be of types best suited for the intended purpose and of a composition that will not support galvanic action.
- (2) Galvanic action can be avoided by insulating different metals from each other. There are many insulating materials and each is best suited for a particular metal or metals. Check with the Construction Manager before permitting such work to be accomplished if you have any doubts.
- (3) Expansion joints are most important and their specification requirements relative to sheet metal installations must be observed.
- (4) Flashings
 - (a) Wherever joints occur, where dissimilar materials come together or there is a possibility of leakage, it is usually necessary to insert flashing (sheet or membranes of waterproof materials) to turn back the water.
 - (b) Determine the type of material specified, gage, weight, and width, as required for the various types of flashings.

- (c) Every joint and seam should be thoroughly checked to ensure prevention of leaks.
 - (d) Verify that base flashing is installed at the edge of roofing and intersections of vertical or similar surfaces.
 - (e) Verify that cap flashing or counter-flashing is built into the vertical wall and turns down over base flashings for the distance required by specifications. (Flashings, placed in horizontal joints of masonry extending through the wall, to prevent dampness and water penetration either up or down the wall, are called "throughwall flashings".)
- (5) Gutters must be firmly attached with screws or bolts spaced as specified and contain a constant slope in the direction of flow. Gutter joints should be inspected as thoroughly as other sheet metal joints.
- (6) Inspect gravel stops for lapped and soldered joints, and for insulation if dissimilar metals have been used.
- (7) Louvers should be inspected for rigidity and vibration and type of paint and color. Check edges of the blades to see that they have been folded or beaded for strength. Verify that insect or bird screens have been installed where required by the specifications.

3.14 Standing Seam Metal Roof (CSI Division 7)

A. Inspection of Materials

- (1) Specifications generally require samples of items for installation to be submitted for approval. Materials received at the job site should be inspected for conformance with previously approved samples. Fabricated materials should be checked with shop drawings, contract drawings, and/or specifications. Check thickness of metal panels with a sheet metal gauge.

B. Storage

- (1) Inspect job site storage to ensure metal panels are:
- (a) Stored in a clean, dry area if possible or covered and sloped for drainage if necessary.
 - (b) Protected from abuse by traffic or from contamination by corrosive or staining materials.

(2) Ensure that stored materials and unfinished work are secured against wind damage.

(3) If panels are protected by a removable plastic film, this film should only be removed immediately prior to installation.

C. Installation

(1) Ensure that metal panels are installed only when the substrate and/or sub frame is installed and aligned to acceptable tolerances as recommended by the panel manufacturer.

(2) During installation, it is the Contractor's responsibility to provide walk board in areas of heavy traffic or other measures to prevent damage from construction crews.

(3) Ensure that all work is installed in accordance with approved shop details under direct supervision of an experienced sheet metal craftsman.

(4) Check that attachments and joints are installed to allow for expansion and contraction from temperature changes without distortion or elongation of fastening holes.

(5) Ensure that flashings are installed in strict accordance with recommended practices.

(6) Ensure that panels are caulked, sealed and fastened to provide a complete weather tight installation.

(7) Ensure that standing seam roof panels are mechanically seamed on the roof with a seaming tool.

D. Cleanup

(1) As work progresses, ensure that excess scrap and debris are removed from the working surface and surrounding area on a daily basis.

(2) The Contractor should touch-up areas as required or directed with manufacturer's touch-up paint.

(3) Ensure that panels are free of stains and scratches. Contractor should wash panel surfaces if necessary.

3.15 **Ceramic and Quarry Tile** (CSI Division 9)

A. **Material**

Verify that all materials needed for installation of the tile have been approved. Check size, color and pattern of furnished tile. Compare all material delivered with approved samples and literature.

B. **Installation of Wall Tile**

Inspect the preparation for placement of tile. Check location and anchorage of studs and furring. Check scratch-coat and float-coat operations, the composition and workability of the mix used, and the application and curing. Inspect the setting of tile for:

- (1) Straight; level, perpendicular and uniform joints.
- (2) Firmness of set.
- (3) Damaged or defective tile.
- (4) Secure installation of accessories.
- (5) Proper application by the adhesive method. Inspect the grouting operation for placing of grout, tooling, cleaning, temperature and method of curing.

C. **Installation of Floor Tile**

Ensure that the walls are installed before floors are installed. Check layout, preparation of setting bed and bed mix. Do not allow Contractor to place excessive setting bed ahead of tiling operation since tile cannot be placed on material that has obtained initial set.

3.16 **Resilient Floor Covering/Tile** (CSI Division 9)

A. **General**

The Contractor must submit samples and obtain approval of all materials needed for installation of the floor. Compare material delivered to the site with approved samples and check the material against contract requirements.

B. **Inspection of Materials**

Tile must be inspected for specified size, thickness and color, as well as

for accuracy of true square cut edges.

Tile containers must not be opened prior to delivery to assure that the tile is of the grade and color previously approved. This also applies to containers holding the cementing materials for tile application.

C. Inspection of Installations

(1) To secure a good bond between the resilient floor covering/tile and subfloor, the subfloor must be vacuumed clean, free from dust, dry, and smooth. Irregularities of the subfloor will tend to protrude through the tile, or cause other irregularities in the finished floor. Indented surface defects should be filled with plastic material manufactured for that purpose.

(2) Materials should be stored above the minimum temperature and for the period specified before installation. Like precautions must be taken relative to the spaces where tile is to be installed.

(3) The specification/plan requirements for the placement pattern or design should be known by the Inspector and installed accordingly.

(4) During the application of felt underlayment, where required by the plans/specifications, ensure that all edges are butted, not lapped, and are carefully cut to fit around vertical surfaces. The felt must always be rolled with a linoleum-type roller of specified weight.

(5) After application of cement, sufficient time must be allowed to dry or set up cement until its surface is tacky. The time required to set up is governed by the type of cement, temperature, humidity and ventilation in the area. Placing of tile on the cement too early or too late results in incomplete bonding of tile.

(6) Upon completion, the finished floor should be thoroughly cleaned and protected from traffic to prevent injury to the finished tile surface. Cleaning should not be done with a solvent type cleaner, due to possibility of damage to the tile.

3.17 **Carpentry and Millwork** (CSI Division 6)

A. General

Check contract for items requiring submission and approval of shop drawings. Verify that all shop drawings have been approved prior to installation. Check materials delivered to site against approved samples.

3-23

B. Inspection of Materials

(1) Lumber

- (a) All lumber should be examined for required official grade marking and presence of large or loose knots or other defects which would impair its strength/durability. If lumber is not grade marked, request that the Contractor obtain a certificate covering the grade.
- (b) Lumber should be stored off the ground to ensure proper drainage, ventilation, and protection from weather. Interior finish wood materials such as doors, floors, millwork, etc., must be stored in weathertight, dry buildings.
- (c) Treated lumber should be inspected for compliance with the specification. As required by specification, a certification of the treatment should be available.

C. Inspection of Installations

- (1) Treated lumber that is sawed or cut after treatment must have the sawed and/or cut surfaces brush coated with a compatible preservative.
- (2) Framing
 - (a) General
 - 1) Framing must be closely fitted and rigidly secured in place.
 - 2) No framing members shall be cut, notched or bored for the passage of pipes and ducts without prior approval or as indicated in specifications/ plans.
 - 3) Damaged framing members should be reinforced or replaced.
 - 4) Framing timbers and girders must have all joints neatly made and provide a solid bearing over the entire area of the joint.
 - 5) Joists or beams to support weight should not be reduced in vertical dimension at bearing ends by notching or cutting away the underside, except as necessary for sizing a member to uniform height.

(b) Partitions and Walls

- 1) Anchors for plates should be of the size and spacing required.
- 2) Construction of headers over openings should be inspected for compliance with specifications.
- 3) All bearing partitions should be provided with double top plates.
- 4) Exterior walls should have diagonal braces installed, when required by specifications.
- 5) Blocking for support of fixtures should be of ample size, closely fitted and rigidly secured in place.
- 6) Studs should be doubled at openings and tripled at corners.

(c) Floor

- 1) The length of each joist should be sufficient for at least a 4-inch bearing at each end.
- 2) In framing joists for masonry, the ends should be cut at an angle for "self-releasing" if specified. In case fire should burn through a joist and cause it to fall, this will preclude the supporting wall from being broken or tilted over. Full bearing should be provided at the bottom of the joist.
- 3) If foundation sills are not required, floor joists can rest directly upon the concrete or masonry foundation. In such construction, it is difficult to obtain a smooth, level surface on which to rest the joists, and it may be necessary to shim under some joists. Where shims are necessary, their use must be in accordance with specifications .
- 4) Foundation sills should be level when placed on concrete or masonry foundations. It is good practice to spread a bed of mortar on the foundation and lay the sill on it at once, tapping gently to secure even bearing throughout its length. The nuts on anchor bolts should not be pulled down until mortar has set. Sill sealer should be used per specifications for a water-tight seal.

- 5) Notching of joists over the member on which they bear should be avoided whenever possible.
- 6) Where a joist rests on a ledger strip and is notched to overlap a girder, clearance should be provided in the notch over the girder so that joist will bear only on ledger strip.
- 7) Bathroom joists must support unusually heavy dead loads due to plumbing fixtures and possibly a tile floor. They should not be weakened by cutting for waste, soil or water pipes.
- 8) Joists framed into headers and girders should be carried on joist hangers.
- 9) Joists supported on the lower flange of steel beams in floor construction require special means of anchoring. Specifications will normally describe the required method.

(d) Roof

- 1) Wall plates on masonry walls should be set level in beds of fresh mortar and secured with anchor bolts. Nuts for anchor bolts should not be pulled down tight until the mortar has set.
- 2) Determine from the drawings whether wall plates are to be single or double.
- 3) Blocking should be provided between rafters where necessary to form nailers for roof sheathing.
- 4) Specifications may require that hip and valley rafters be secured to wall plates by clip angles.

(3) Bridging

- (a) The top of the joist must be brought to a straight line before placing and nailing the bridging. Bridging can be cut and placed by nailing the top end to joist. Nailing of bottom ends of bridging should be deferred until after placement of subfloor and, if possible after placement of finished floor to allow tops of joists to be drawn into better alignment.

(b) Bridging strips should have ends accurately level cut to allow firm contact with sides of joists.

(c) To prevent a sliding movement of metal bridging, nails used to secure this type of bridging should be of a correct size to fit punched holes.

(4) Wall Sheathing

(a) Vertical joints between plywood sheets should not be on the same stud in succeeding rows of sheathing. For horizontal joints, and vertical joints where necessary, blocking should be set between the studs.

(b) Waterproof sheathing paper should be installed as required by specifications/plans.

(c) Requirements for metal ties should be determined and ties installed as required.

(d) The acceptable thickness of plywood sheathing will normally be determined by drawing requirements.

(e) Fiberboard sheathing should be applied with required allowance for expansion at ends and edges except at opening frames.

(f) Styrofoam sheathing and bracing should be installed per specifications.

(g) The specified type of nails for mounting **fiberboard and** gypsum sheathing should be used.

(h) Fiberboard and gypsum sheathing should be applied horizontally with joints over supports and staggered.

(5) Roof Sheathing

(a) Sheathing should be of the type and thickness required.

(b) Plywood sheathing should be applied with grain of the face plies across rafters.

(c) Nails of appropriate size should be used for applying sheathing and spaced as required.

(d) Specifications may require that exposed sheathing boards or planks, at eaves and other locations be V-jointed, dressed, and matched.

(6) Subflooring

(a) The butt joints of wood subflooring should be staggered and over supports, with ends cut parallel to joists and adhesive used per specifications.

(b) The top of subflooring should be tested for a true, even plane.

(c) Plywood subflooring should be installed with the grain of face plies across joists. Solid backing should be provided under edges at right angles to joists.

(7) Framing

When framing stair stringers, verify that stringer has solid bearing at its back edge at both top and bottom end of stringer.

(8) Exterior Finish

As finish woodwork of the building is installed, it should be protected from damage.

(9) Window Frames

(a) Before setting window frames, verify that they are constructed as specified and detailed.

(b) When setting in masonry wall, verify they are braced so that the mason cannot knock them out of position when laying the brick or other masonry. The frames are to be square and so braced.

(c) Window units should be plumb and level without warp or rack of frames. Double-hung windows should glide freely without binding.

(10) Doors

The top and bottom edges of exterior wood doors should be given specified coats of appropriate finish. If the top and/or

bottom edges are cut at the job site, two coats of finish should be applied immediately.

(11) Interior Finish Trim

- (a) Molding should be mitered at corners and coped at angles.
- (b) The shoe mold should be nailed to flooring and not to the base mold, except where finish floors are other than wood. In this case, the shoe mold shall be nailed to base.

(12) Finish Floors

- (a) The finish floor should be perpendicular to floor joists.
- (b) When subflooring of any type has become warped or loosened, it should be securely renailed before placing the finish floor.
- (c) Cross joints in wood floors should be well distributed, and unless the flooring is end-matched and laid on a subfloor, joints should be made over solid bearings.
- (d) If the flooring drives up with difficulty, a wood block or piece of 2" x 4" should be used against the tongue to prevent damage.
- (e) Nails securing tongue and groove flooring should be driven at an angle of 45 degrees or more to obtain as much penetration in the joists or blocking as possible.
- (f) Only flooring nails approved for the installation should be used for nailing floors.
- (g) The ends of the flooring should be cut at a slight under bevel to permit the top of the board ends to form a tight joint.

D. Millwork

(1) General

All work under this heading generally concerns manufactured items produced in a shop or mill and in most cases requires approval of shop drawings prior to assembly.

(2) Inspection of Materials

(a) Immediately upon delivery of the units, their construction should be checked with previously approved shop drawings, giving special attention to:

1) Type of material and method of jointing. 2) Bracing of corners. 3) Thickness of materials. 4) Proper fit of doors flush with the openings. 5) Type and construction of the drawer guides. 6) Joint between counter and splashback. 7) Approved finish or sealer and primer.

(b) Storage in weathertight, dry building until installation.

3.18 Insulation Material (CSI Division 7)

- A. Insulation material should be of the type, thickness, and quality previously approved.
- B. Insulation materials are manufactured in many forms and types (having certain advantages and disadvantages) which vary in thermal properties for specific job requirements. (Note: Any work being done with asbestos or asbestos-containing material must be coordinated with the servicing Safety Office.)
- C. Fiberglass insulation should not be exposed.

3.19 Acoustical Treatment (CSI Division 9)

- A. General - Acoustical treatment is the term used for sound or noise control.
- B. Inspection of Materials
 - (1) Acoustical tile or acoustical plaster (the two most generally used) have sound absorbing qualities and are described in specifications as to type and class. Gypsum board is often used as a back-up for acoustical tile. This provides a mounting surface for tile and gives rigidity. The tile may be applied to concrete or other surfaces. The cementing material or fastening devices are important and verification of proper materials must be made.
 - (2) Mechanical accessories are generally well-defined in specifications. The purpose of accessories is to support acoustical units

without sagging and to bring faces of the units to defined finished lines and levels.

(3) Containers should be unopened and marked as to color, specification compliance, etc. Containers should be spot-checked and contents checked at random for contract compliance.

C. Inspection of Installations

(1) Generally, all ceiling units should be laid out in a square pattern, symmetrical about the center lines of each room, space or panel.

(2) Following completion of acoustical treatment for ceilings, all joints should be straight and true to line, and exposed surfaces should be flush and level. Acoustical tile may be applied to sloped ceilings.

(3) When placing acoustical tile on walls, channels should be shimmed where necessary to obtain true and plumb alignment.

3.20 **Drywall Finish** (CSI Division 9)

A. Inspection of Materials

(1) Inspect wallboard upon delivery to job site for conformance with specifications and possible damage during shipment and handling.

(2) Gypsum wallboard should be stacked flat and not in areas where it is likely that corners or edges might be damaged.

B. Inspection of Installations

(1) Require headers or bridging where necessary to provide a firm backing behind all edges.

(2) Apply wallboard so as to minimize the number of joints in accordance with specifications. Installation should start with the ceiling. Wall installation should start at a corner of the room.

(3) Wallboard must be held firmly against the framing while nailing and care must be taken not to over-drive nails and damage the surface. The bottom should be a minimum of 1/4-inch off floor.

(4) The size, type of nails/screws and spacing must be per spec's.

(5) Wallboard should be cut such that it doesn't have to be forced into place. When cutting or scoring wallboard, the cut should be made

from the finished side of the wallboard.

(6) Good workmanship is important in concealing joints, nailing depressions, and in corner treatment. Joint cement should be sanded only as necessary, with care being taken not to scuff the wallboard surface. Special attention should be given to application of tape and other specified treatment to corners, both internal and external.

3.21 **Glass and Glazing** (CSI Division 8)

A. General

Be familiar with the various types of glass required and the locations in which each type is to be installed. Verify that each type is approved before use. Materials should be installed per manufacturer's recommendations and contract specifications.

B. Installation

(1) Prism glass of all types should be set with prisms on the room side of sash, so the prism will reflect light into the room.

(2) All glass and mirrors should be factory labeled on each pane, and labels should not be removed until authorized by the Inspector.

(3) Specifications generally require that obscure glass should be used for glazing doors and sashes of windows in toilets, baths and dressing rooms. Obscure glass should be set with smooth surface to the exterior and with the surface design in one direction, unless otherwise required by specifications.

3.22 **Hardware** (CSI Division 8)

A. General

Compare hardware against schedule for the project. Hardware for doors or other items should be installed and fastened in place in accordance with manufacturer's directions.

B. Installation

Hinge pins should be plumb through all hinges on any given door. All hinged, pivoted, sliding or otherwise movable hardware should work free and easily. Materials to which hardware is attached must not be damaged during installation. Door closing devices should not interfere with screen or storm door operation or block openings. Determine

number of keys required and have all keys tagged as to location. Final acceptance of hardware requires a demonstration that the hardware performs satisfactorily.

3.23 **Painting** (CSI Division 9)

A. Inspection of Materials

(1) The contract and referenced specifications describe the method of application and quality materials. These requirements should be followed without deviation.

(2) Upon delivery of materials to the job site, verify that they are in accordance with previously approved samples.

(3) All paint materials must be the brand, type and/or grade previously approved and should be delivered to job in original, unbroken containers with labels and tags intact. (GOVERNMENT REGULATIONS PROHIBIT USE OF LEAD-BASED PAINT.)

(4) All material should be stored for protection from weather during construction.

B. Installation

(1) No inspection of painting should be undertaken without full knowledge of contract and referenced specifications. If any doubt of method of application exists, contact the Construction Manager.

(2) Ascertain from the specifications/plans the surfaces to be finished and type of coating to be applied.

(3) All hardware, electrical fixtures and similar accessories should be removed during painting operations. Radiators and other equipment adjacent to walls should be disconnected and removed to paint the wall surface.

(4) Prior to painting, imperfections and holes in surfaces should be filled or removed in an approved manner.

(5) All surfaces to be painted should be clean, smooth, dry and free from dust, grit and frost.

(6) Verify that surface to be painted is at specified temperature, as well as the surrounding air. Temperature should be at or above the specified minimum until paint has thoroughly dried.

3.24 **Electrical Work - Interior** (CSI Division 16)

A. General

Inspection of this phase of construction is most important. Poor workmanship and nonapproved materials can be hidden until trouble develops after the Contractor has left the job.

B. Inspection of Materials

(1) In general, each electrical specification requires a comprehensive submittal of shop drawings and/or catalog cuts for approval. At least one copy of the approved submittals should be available on the job site for use in inspecting prior to installation.

(2) Comments on shop drawings should be carefully checked in the field for compliance.

(3) Some electrical materials are delicate, such as control relays, and certain switching devices. They should be stored where dust and moisture will not damage them. All materials should be protected from moisture.

(4) Lighting fixtures should be stored so as to eliminate damage to finishes and reflective surfaces.

C. Installation

(1) Applicable Specifications and Standards

(a) The standard reference code is the NFPA National Electrical Code (NEC). Other codes and regulations that may be applicable are:

1) Requirements that may be set by local utility companies.

(2) Grounding

(a) The neutral conductor and conduit system should be grounded as described in NEC and the contract specifications.

(b) The grounded conductor of an interior wiring system should have a color identification used continuously throughout

the system. The colors, white or natural gray, are usually used for identifying the neutral or grounded conductor on insulated conductors, No. 6 gage and smaller. On conductors larger than No. 6, the neutral should be distinctively marked at the terminals.

(3) Conduit

(a) Many types of wiring methods are approved by the NEC, but in each contract the wiring method is clearly defined. In most cases, polyvinyl chloride, rigid metal conduit or electrical metallic tubing are required.

1) Rigid conduit provides protection to the conductors and acts as an effective grounding conductor for equipment. Rigid conduit may be used under most conditions.

2) EMT (Electric Metallic Tubing) is, in general, approved for use under the same conditions as rigid metal conduit, except that it may not be used in exterior locations in any size larger than two (2) inch nominal internal diameter, and may not contain any conductor operating at a voltage higher than 600 volts.

(b) A run of conduit or EMT between any two outlets, between any two fittings, or between an outlet and a fitting, should not contain more than the equivalent of four 90-degree bends or quarter bends (360 degrees total), including those bends located immediately at the outlet or fitting. This requirement permits conductors to be pulled into the conduit or EMT without using so much force that there is a likelihood of damaging insulation or stretching wires.

(c) Conduit or EMT which has been crushed or deformed in any way must not be installed.

(d) Conduit or EMT should be well supported. The method of support is generally stated in contract specifications.

(e) Conduit or EMT should be secured at each outlet or junction box with locknuts. This effectively makes a continuous grounded conduit and equipment system.

(4) Conductors

Each wire or cable is marked or stamped at intervals on the

insulation as to the size and type of wire. Check this against contract specifications and/or drawing requirements. Verify that the number of wires in any conduit is in accordance with tables in the National Electric Code.

(5) Tests

(a) Listed below are a few of the tests, but the list is general and may not be complete for every job.

1) Check all fixtures for proper operation.

2) Check all motors for proper rotation. During mechanical tests, check motor for overheating. If motors are too hot to hold your hand on, they should be checked for overloading.

3) Check all convenience outlets (120 volts or 220 volts) with a meter.

4) Check remote control circuits for function and operation.

(b) More complete and complicated tests and inspections can be accomplished as required by an electrical engineer upon request of the Inspector.

3.25 **Electrical Work - Exterior** (CSI Division 16)

A. **General**

Frequently, the greater portion of exterior electrical work is performed by a public utility company or the equivalent. In such cases, the Inspector should determine that materials and equipment will meet power requirements for the completed project. Usually in cases of this sort the Inspector needs to be concerned no further than the mast. Contractor installed exterior work must be inspected as thoroughly as interior work. Request the services of an electrical engineer when electrical work is proceeding at a rapid pace, especially on larger projects.

3.26 **Plumbing** (CSI Division 15)

(1) The functions of the plumbing system are for distribution of

water and disposing of wastes. Plumbing systems generally include hot and-cold water piping, drains, wastes, vents, fixtures, insulation, water heater, and fire protection-located within the building and outside to a specified point of connection with various utilities.

(2) Materials for the plumbing system are included in the specifications.

B. Inspection of Materials

(1) Pipe and tubing should be of the type and grade required by the specifications, and should be free from kinks, sharp bends, or dents. Piping and tubing are identifiable by markings placed by the manufacturer on each section. Piping and tubing should be stored for protection from the elements.

(2) Valves should be inspected to ensure the specified type and ratings are in accordance with requirements. The working pressure rating of the valve, size and manufacturer's initials are cast on the body of the valve. Internal parts of valves should be inspected to ensure they have not been damaged during shipment, storage or installation.

(3) Fixtures should be inspected to ascertain compliance with contract specifications, approvals and for possible damage such as chips or cracks.

C. Installation

(1) During installation the services of a mechanical engineer or technician may be necessary.

(a) Water pipe sizes vary considerably between different materials specified for the same nominal size. Do not permit substitution of sizes and types of pipe as it may seriously affect operation of the system.

(b) Hot-water lines should be installed with the slope shown on contract drawings, or as stated in specifications.

(c) Positive circulation of hot water is provided by the addition of a hot water circulating pump. The pump is provided to maintain water at fixtures in accordance with the specified temperature setting. Pumps are either manually controlled or automatically controlled by thermostats actuated by temperature change of (domestic-use) water.

(d) Air release valves vents, when required, should be installed at high points in the system to relieve air and prevent air locks.

(e) Specifications may require cold water piping to be installed with a fall towards the shut-off point to allow the entire system to be drained and thus prevent freezing.

(f) Specifications usually require air chambers to be installed near each valve or faucet. These are necessary to prevent damage to the system by water hammer which can be of sufficient magnitude to burst the pipe.

(2) Soil, waste, drain and vent piping should be installed to provide a gas-tight system.

(a) Soil pipes are defined as pipes that receive discharge from water closets and similar fixtures.

(b) Waste pipes receive the flow from fixtures other than water closets.

(c) Vent pipes are installed to provide air to the system to prevent air locks in lines and to prevent the water seal from being siphoned from traps.

(d) Drain pipes of the plumbing system are the lowest pipes which receive the flow from waste and soil pipes. This line connects the plumbing system to the building sewer.

(e) Soil, waste and drain lines are usually specified to be installed with a grade of 1/4-inch per foot, where possible, and in no case should they be less than 1/8-inch per foot. This fall in the lines is required to prevent settlement of the solids being transported by the fluid.

(t) Drains carrying rainwater from the roof and other exterior areas should have a grade greater than conventional drains, because included sand and dirt particles must be transported more rapidly to prevent settlement.

(g) It is generally required that vents be run full size from the line being vented to above the roof line as shown on drawings. This requirement should be met to provide a free drainage of the system.

(h) Floor drains installed in areas with waterproofed floors

should be inspected to ascertain that the weep holes are above the waterproofing and are open to provide drainage for any moisture seeping through the surface of the floor.

(i) Vents should be installed so that any moisture collected therein will drain back to the soil or waste pipes by gravity without passing through any traps or pockets in the piping.

(j) There should be no cross-connection between the soil, waste, drain, or vent piping and the potable drinkable water system.

(k) Each fixture should be trapped as required. No fixture should be double-trapped. Traps on threaded pipes should be drainage type.

(3) Shower pans are installed to prevent moisture from seeping into materials below the shower floor. Pans fabricated in the field should be inspected carefully prior to placing of the shower floor to detect holes in the pan or any corners not folded properly.

(4) Sump pumps should be of the capacity and size as specified on drawings. Inspect the bearings for grease, floats for soundness (not punctured) and controls. After installation, inspect for proper operation. These pumps have been specified to lift waste to the waste line.

(5) The standpipes and hose systems should be installed in strict accordance with contract specifications/plans and National Fire Protection Association codes. Piping is to be concealed in the finished work and carefully inspected and tested for leaks prior to construction of the concealing wall or ceiling. Caulking or peening joints to stop leaks is not permitted. Hoses should be clean, dry and unused.

(6) Mitering of pipes and/or joints for elbows and notching of straight runs of pipe for tees is not permitted. This specification requirement is intended to obtain fittings with adequate strength and ones that present smooth, rounded corners to the flow in the pipe.

(7) Pipe openings should be kept closed with caps or plugs during installation to prevent dirt, rodents, and foreign waste from entering the system.

(8) Union connections are provided for a simple means of disconnecting equipment or fixtures. Locate unions so that they are accessible. Do not cover unions with insulation.

- (9) Pipe insulation should conform to the type, material and thickness specified and should be installed to present a neat and smooth appearance.
- (10) Pipe hanger specifications usually require that hangers have an approved means for adjustment. Such hangers permit adjustment of pipe to grade while supported without removing hangers from pipe. Check that temporary supports are removed after lines are graded and/or completed.
- (11) Pipes should not be run through footings, piers, beams or floor joists unless specifically shown on the drawings. This prevents weakening of the load-carrying members of the structure.
- (12) Floor, wall and ceiling escutcheon plates are usually required by specifications to be installed on bare, exposed pipes passing through floors, finished walls or finished ceilings, to close the space around the pipe and to give the room a neat and finished appearance. Usually sleeves through walls/floors are required. Specified insulation may be required at firewalls.
- (13) Fixtures should be solidly fastened as required and free from cracks or chips. Valves, such as flush valves, should be adjusted for proper operation. All plumbing fixtures and/or equipment should be clean and ready for immediate use.
- (14) Tests
- (a) Specifications require that all piping installed be tested prior to painting, covering or being concealed. Equipment required for testing should be furnished by the Contractor unless otherwise stated by the specifications.
 - (b) It is mandatory that the Inspector witness all tests and record results in the Project Diary and Daily Log.
 - (c) All tests must be performed in strict accordance with contract specification requirements.
- (15) Sterilization
- The entire domestic water piping system, both within buildings and outside, must be sterilized as required by specifications.
- (16) Electrically Controlled Items

If necessary, request that a mechanical engineer or technician inspect the electrical hook-ups for electrically controlled valves, thermostats, motors, etc.

3.27 **Heating, All Types** (CSI Division 15)

A. General

This section covers material and equipment for heating systems, including heat generators located within the structure. Central heating plants are not included. As heating system controls are highly sensitive, materials, equipment and installation must be as specified and approved to obtain satisfactory and efficient operation. Due to its complexity, all phases of this work must be thoroughly inspected. Generally, approved submittals and details supersede the specifications, as each manufacturer has specifically designed equipment.

B. Inspection

All material and equipment must be inspected after arrival on site and prior to installation. Use approved brochures and literature as well as listed approved materials and equipment. The following inspection steps are important throughout the job:

- (1) Reject and order removal of damaged material and equipment.
- (2) Any modification of previous construction for installation should not be permitted without prior approval.
- (3) Unions and flanges should not be insulated.
- (4) Discuss coordination of work of other crafts with Contractor's Superintendent.
- (5) Check nameplate data on all equipment prior to installation.
- (6) Check installation of all equipment for compliance with manufacturer's recommendations.
- (7) Materials and equipment must be properly stored and protected.
- (8) Check accessibility of controls, valves, access panels and ease of boiler tube removal.
- (9) Verify that operating and maintenance instructions are properly posted.

(10) Check spare parts and tools required to be furnished.

(11) Check all systems for leaks of any type.

C. Boilers, Furnaces and Accessory Equipment

(1) Check installation dimensions and clearances per code of all types of boilers for accurate setting.

(2) Generally applicable inspection steps are for:

- (a) Tightness of joints
- (b) Cracked Sections
- (c) Refractory brick/mortar and firebox construction
- (d) Expansion joints
- (e) Packing to prevent gas or air leakage
- (f) Air cooling under boilers
- (g) Application of insulation and materials
- (h) Safety items: low water cut-off, flame failure, alarms, pop valves, fusible plugs, and backflow prevention if connected to potable water system.

1) Valve Units - Variable air-volume units should have shut-off valves to supply and return piping. For hot water and steam pipes ensure that safety relief valves have been installed and have rigid discharge pipe.

2) Hot water boilers - Ensure that combination pressure temperature gauge is installed for hot water systems, and that discharge pipes are inspected for expansion tube.

3) Steam boilers - Inspect the required equalizing pipe, low water cut-off, blow-off valve, water gauge glass and pressure gauge indicating normal range.

(i) Accessory equipment and operation: feed water controllers, dampers, pressure and draft gages; flow and pressure recorders; soot blowers, water columns, boiler blow-down; and pressurestat.

(j) Witness boiler tests to maximum system pressure and operation of all accessory equipment and drying of boiler if not put to use immediately. Ensure that manufacturer training is provided to maintenance personnel.

D. Fuel Burning Equipment

- (1) Oil burners, Check the following:
 - (a) Size of burner.
 - (b) Location of electrode to ensure ignition of oil.
 - (c) Position of pilot.
 - (d) Clearances for removal of burner from furnace.
 - (e) Burner adjustments.
 - (f) Carbon dioxide in flue gas
 - (g) Ensure that burner pump does not lose its prime when shut down.
 - (h) Ensure proper combustion air per manufacturer's recommendations and code (40 cu. ft./1000 BTU input).
- (2) Gas Burners - Check burners for cleanliness, adjustment and position of pilot flame and sensing element.
 - (a) Ensure that gas line is blown out before connection to burner or regulator.
 - (b) Check for proper installation of regulator.
 - (c) Vent gases to the outdoors.
 - (d) Ensure proper combustion air per manufacturer's recommendation and code (40 cu. ft. / 1000 BTU input).

E. Draft Fans

- (1) Inspect fans and drives for anchorage, alignment and rotation.
- (2) Check damper functioning.
- (3) Check bearings for smoothness, overheating, vibration.
- (4) Check insulation application to induced draft fan.
- (5) Check installation of safety control interlocks/air-flow switches.
- (6) Check space for maintenance and repair.

F. Controls

- (1) Witness proper operation of safety controls and automatic controls (i.e., thermostat operation).
- (2) Check combustion control operators for support, hookup and efficiency.

G. Stacks and Chimneys

- (1) Check support at the base and either guys or supports at intervals as height requires.
- (2) Check gage of stack plates.
- (3) Check clearance and insulation between stack and roof.
- (4) Inspect application and fastening of insulation.
- (5) Observe protective painting if applied on job. Otherwise inspect for damage.
- (6) Ensure proper elevation per code (height should be 2 feet higher than any portion of the building within 10 feet).

H. Feedwater Treatment and Softening

- (1) Ensure proper chemical dosage and operation.
- (2) Witness maintenance instructions and operations.
- (3) Reduced pressure and backflow preventer should be installed if connected to potable water system.

I. Heating Systems

- (1) Check piping installation for expansion and contraction; clearances at openings and equipments; and strain at connections to equipment.

Check installation of mechanical expansion joints. Do not remove spacers until the joint has been installed in the line. Ensure proper lubrication and installation of clean filters.

- (2) Check additionally for:
 - (a) Kinks, wrinkles or other malformations in pipe bends.
 - (b) Pitch of horizontal runs of pipe.
 - (c) Position of branch connections.
 - (d) Use and proper installation of eccentric fittings.

(e) Position of valves. Supply and return line shut-off valves should be installed at every heat exchange, both sides of pressure reducers and valves on convectors to any pressure vessel and on building supply and return to central system.

(f) Spacing of hangers and that openings in walls are not used as pipe supports.

(g) Reaming of inside of pipe ends.

(h) Sharpness and length of threads.

(i) Location and access to air-release fittings.

(3) For two-pipe systems, check all radiator, drip, and boiler return traps for capacity requirements. Inspect all condensate and vacuum return pumps for nameplate capacity rating. Check for drip traps at ends and low points in steam mains, ahead of heating units on long runouts and at other points where condensate may accumulate.

Check for presence of fittings where gravity flow of vacuum returns is interrupted by change to higher elevation. Verify that all steam supply and return lines are clean before allowing operation of systems.

(4) Hot water systems

(a) Check lines for leveling, alignment and stability on foundation; lubrication; seals for leaks; packing adjustment/type; and pressure retention.

(b) Ensure that radiant heating coils are accurately placed, firmly secured, and tested absolutely watertight prior to encasement in construction.

(c) Ensure that air pockets and restrictions are eliminated, high points vented, and that the entire system can be drained.

(d) Check installation of balancing valves and orifices in the return connection of each radiator or heating device.

(e) Check balance and flow distribution.

(f) Converters - Verify that threaded openings are provided; that safety devices and temperature controls are furnished; and controls are in working order. Check coil for tightness and

clearance for its removal. Check drain pipe to outside atmosphere and floor drain from blow-off safety valves.

(g) Circulating Pumps - Check mounting, capacity and operation and nameplate for compliance with approval action.

(h) Expansion Tanks - Check for size, conformance to code, protective paint coating, insulation, water level gage, drain and air charging valves.

(5) Hot air heating

(a) Verify that flue gas does not contaminate the heated air. Check return air for free passage back to heater unit.

(b) Check for balancing of dampers for proper air distribution.

(c) Check for gas burning equipment, and ensure smoke detector installation.

(6) Accessory Equipment

(a) Check the size and location of radiators and convectors to ensure proper fin tube and baseboard radiation; and hangers to ensure that proper expansion is permitted and piping imposes no strain on the units.

(b) Heating/ventilating units - All component parts must **operate** satisfactorily. Check access doors for tightness and clearance. Noise level must be within acceptable limits. Check for flexible pipe connections and/or vibration eliminators. Verify flexible connections to vibrating equipment.

(c) Unit heaters - Check for proper air distribution; noise level; operating controls; and clearances.

J. Operating Instructions

Witness all operations and verify that instructions for operating of equipment are furnished. Record names of instructing personnel and those who are instructed.

3.28 Ventilation Systems (CSI Division 15)

A. General Requirements

a. Fans

Inspect for proper rotation direction; lubrication of bearings; belt tension and alignment; and vibration.

(2) Filter

Viscous type should include washing tank and spare filters. Check access for replacement and ensure that clean filters are installed after final testing.

(3) Ventilators

(a) Power Roof Type - Inspect for: service access door; flashing at curbs is watertight; operation of automatic dampers; and direct discharge of fan away from air intakes or exhaust outlets. For fume hood, stack must extend 8 feet above roof level.

(b) Gravity type - Check for free rotation.

(c) Back draft dampers - Check for felt on edges of blades and condition of blades.

(d) Check goosenecks and rain hoods for flashing and bracing and that goosenecks face away from the wind.

(e) Screens - Check mesh size.

(4) Duct Work Construction

(a) Check material thickness and bends for center line radii.

(b) Check vanes in right-angle elbows.

(c) Ensure tightness of installation against leakage and vibration. Specifications may require testing.

(d) Check transitions for no slopes exceeding 1 in 5. If greater slope is necessary, provide splitter vanes.

(e) Check for obstructions inside duct work prior to operation of system. If absolutely necessary to run pipes or conduits through ducts, they should be encased in streamlined sleeves. If obstruction is more than 15 percent of the cross-sectional area, increase area to maintain the original cross-section.

(f) Check access doors at all fire dampers, automatic dampers, coils, filters, heaters, thermostats, or any item that requires servicing. Verify that doors are airtight, securely fastened, accessible and can be fully opened.

(5) Duct Work Erection

(a) Check lock seams and breaks in duct work for cracks. Reject damaged ducts.

(b) Verify that drive slide ends are cut square and thoroughly beaten over. Ensure that "S" Slips are installed so the interior piece is in direction of air flow.

(c) Inspect hangers for proper support and spacing.

(d) Check canvas connections for weight, fireproofing, slack, and airtight seams. Canvas should not be painted.

(e) Check applications of sound-absorption lining. Check for non-flammable cement and taped exposed edges.

(f) Mark butterfly damper rods.

(g) Check multi-louver damper blades for bearings and closing.

(h) Check tightness of fire dampers.

3.29 **Air Conditioning and Refrigeration** (CSI Division 15)

A. General

This section covers material and equipment for air conditioning and refrigeration systems. General air-flow systems and evaporative cooling systems can be easily inspected. Refrigeration systems are complex and may require the technical assistance from mechanical or electrical engineers.

B General Requirements

(1) Fans, Filters and Duct Work

Refer to the previous section covering ventilation for applicable information. Check diffusers for adjustable pattern operator, distribution grid, and damper. Damper must operate freely.

(2) Refrigeration Equipment and Piping

(a) Check chilled water coils for pitch and vent, and installation for counterflow of water and air.

(b) Direct expansion coils must be installed as recommended by manufacturer.

(c) Pans of fan-coil units must be protected against corrosion. Check sealed joints.

(d) Package type air conditioners - Check the following:

- 1) High pressure cutout setting;
- 2) Compressor hold-down bolts are removed;
- 3) Drip pan is watertight and connected to open drain;
- 4) Water regulator valve operation;
- 5) Installation of air filters and strainers;
- 6) Thermostat operation; and
- 7) Check suction and discharge pressures of refrigeration compressors.

(e) Check humidifiers, steam grid, for supported coil and corrosion-protected pan and correct installation of the unit.

(f) Check refrigeration type dehumidifiers for frosting of cooling coil and water carry-over.

(g) Condensers, air cooled - Verify that air flow is not obstructed and wind deflectors are installed.

(h) Condensers, water cooled - Check for: relief valve of adequate size; spray coverage; and valves for shut off, purge, drain, liquid level.

(i) Condensers, evaporation cooled - Check for: spray coverage; float valve operation without "chatter"; water level; fan rotation and speed; pump suction strainer; mesh size of inlet

screens; pan, casing, eliminators, fan corrosion protection, and complete draining; and provision for and adjustment of constant waste (bleedoff).

(j) Evaporative Coolers - Check for adequate spray coverage, water carry through, correct water level in sump, and float valve "chatter".

(k) Water Chillers - Expansion Type water drain, vents, and correct pass arrangement. Check safety devices for freeze protection.

(l) Water Chillers, flooded - Check for strong liquid bleedoff at bottom of chillers, relief valve, and correct level control adjustment.

(m) Reciprocating compressors - Check for:

- 1) Oil suction and discharge pressures.
- 2) Shaft alignment on direct-driven machines.
- 3) Operation of high and low pressurestat and oil pressure failure switch.
- 4) Oil level and proper oil viscosity.
- 5) Refrigerant charge, amount, and type.
- 6) Pressure holding ability upon pump down.
- 7) Isolator deflection and compressor vibration.
- 8) Suction strainer screen mesh, and removal of startup belts.
- 9) Belt tension and alignment, rotation.
- 10) Compressor motor amperage under maximum load.
- 11) Refrigerant floodback and oil foaming.
- 12) Cylinder head over-heating.
- 13) Automatic oil heater in crank case.
- 14) Loops in refrigerant piping and condenser for an oil trap.

(n) Centrifugal Compressors - Check for:

- 1) Alignment of compressor, drive and gear box.
- 2) Suction damper or inlet vane operation.
- 3) Safety control circuit operation.
- 4) Purge compressor operation.
- 5) Float valve operation.
- 6) Oil pump and oil cooler operation.
- 7) Noise and vibration.

(o) Absorption Refrigeration Machine - Check for:

- 1) Cleanliness of all parts during installation.
- 2) Operation of liquid level control.
- 3) Operation of purge pump.

(p) Refrigerant Receivers - Check for:

- 1) Relief valve of adequate size.
- 2) Valves for shutoff, drain, purge, and liquid level.

(q) Unit Coolers - Check for:

- 1) Corrosion protected pan and casing.
- 2) Water defrost units for spray coverage with no carry over.
- 3) Electric defrost units for cycle timing in accordance with the job conditions.
- 4) Hot gas defrost for suction pressures and refrigerant charge in accordance with manufacturer's recommendations.
- 5) Drainage during defrost cycle.
- 6) Cycle timing.

(r) Refrigeration Specialties - Check for:

- 1) Expansion valves for superheat setting, and for bulb and equalizer position in accordance with the manufacturer's recommendations.
- 2) Solenoid valve for vertical stem, correct direction of refrigerant flow, and manual opener disengaged.
- 3) Sight glass for unobstructed view, clean glass, cap gaskets and practical means for replacement.
- 4) Evaporator pressure regulator under light load for operation.
- 5) Hold-back valve for operation upon start-up.
- 6) Float valves or switches mounted level and at a height which will ensure correct liquid level in the evaporator.
- 7) Refrigerant drier canisters for airtightness before opening.

8) If drier is the replaceable type, piping will be arranged to facilitate replacement.

9) Liquid suction heat exchanger for piping connections.

(s) Refrigerant Piping - Check for:

1) Pipe hangers isolated from the pipe by a strip of lead or rubber.

2) Flexible metal hose for vibration absorption installed at right angles to the motion in the pipe.

3) Cleaning of pipe before erection.

4) Clean joints before soldering in accordance with applicable procedures for refrigerant piping.

5) Dehydrating of the system as recommended by the manufacturer.

6) Charging the system with type and amount of refrigerant.

7) Installation of refrigeration piping size, and type of materials and brazed joints.

8) System leaks and any unnecessary oil traps.

(3) Cooling Towers

(a) Check natural draft cooling towers for guy wires, corrosion protected bolts, watertight basins, cracked or split air louvers, spray coverage, and float valve operation.

(b) Check mechanical draft cooling towers for unobstructed air intake, fan rotation and speed, belt tension, weather protection of motor, and stacked fill. Determine that water flow through outlet does not form a vortex which draws air in with the water and operation of the temperature control and drainage devices.

(c) Check for provision and adjustment of constant water level.

(4) Pumps

(a) Pump Setting - See contract specifications.

(b) Check pumps for packing or mechanical seal construction and recommended seal leakage. Check couplings for alignment and vibration, motor for rotation and weatherproofing.

(5) Controls

(a) Require that control instructions, including sequence of operations, and complete schematic control drawing furnished by the Contractor be used in conducting the final acceptance test. Check each function of the controls. Ensure that all control wire is color coded.

(b) Check damper motors while fan is on.

(c) Check valve operations for tight closing.

(d) Locate air compressors to permit tank drain operation and check for cycle time with all controls operating.

(e) Require clean elements in humidistats when the system is started.

(f) Check duct mounted controls for airtight connections and accessibility.

(g) Determine that pneumatic systems are airtight, that there are no restrictions caused by flattening of the tubing.

(h) Check electronic systems for grounded cable and shielded cable, and location of amplifiers with respect to magnetic fields, such as large transformers.

(i) Check graphic panels for damaged plastic, dirt between plastic and back plate, missing control wires and access for service to all controls.

(j) Check electrical equipment for interlocking.

(6) Insulation

(a) Vapor Sealing - Check insulation pipe or duct work.

(b) Check tightness and spacing of metal bands.

(c) Check canvas covering to ensure cut edges are thoroughly pasted or sewn.

(d) Check strapping for corner protectors.

3.30 **Testing and Training (HVAC Systems)** (CSI Division 15)

A. **General**

Require the Contractor to perform all tests set forth in the specifications and those recommended by the manufacturer. All tests should be witnessed and the following documented:

- (1) Date and time of all tests.
- (2) Names of all personnel witnessing tests.
- (3) All nameplate information.
- (4) File all test data for retention.

B. **Training**

Ensure that proper training is provided for maintenance personnel.

3.31 **Gas Distribution** (CSI Division 15)

A. **General**

(1) This section includes conveyance of natural or artificial gas to outlets, equipment, and appliances within a building from a specified point of connection with the service line. The gas is usually used for heating of facilities and heating water for domestic use.

(2) Many gases are odorless and colorless and burn with a luminous flame. As a safety measure, an odor is added to the gas to enable its detection.

(3) Gas pressure in building pipes is usually measured in inches of water while the pressure in the mains or service line is measured in pounds per square inch.

(4) The contract lists the Federal Specifications applicable to material and the National Board of Fire Underwriters Standard (NBFU) No. 54 which states the minimum requirements for a safe, dependable system. Be familiar with these specifications and codes.

3-54

(5) Contract specifications may require coding of gas piping in accordance with ANSI Scheme for Identification of Piping Systems (ANSI A13.1-1956).

B. **Inspection of Materials**

(1) Piping for the gas system is usually specified as steel or iron with malleable iron fittings, copper, and coated or wrapped pipe.

(a) Inspect pipe and fittings for proper marking and material.

(b) Check for damage, especially to coated pipe, caused by shipping or storing.

(c) Check storing method to ensure cleanliness of pipe and fittings.

(2) Equipment to be installed should be inspected for compliance with contract drawings and specifications. Check labels on the equipment which state that it has been approved by the American Gas Association.

(3) Equipment that has been damaged should be replaced.

(4) Galvanized pipe is usually not specified for gas systems since it offers no great advantage over black pipe (uncoated). However, galvanizing may seal minute pinholes which would otherwise leak.

(5) Fittings should be examined to determine whether or not they are malleable iron fittings. Malleable iron is cast iron which has undergone an extended annealing process to increase ductility.

C. Inspection of Installation

(1) Inspect installation to ensure that it complies with contract plans and specifications, NBFU No. 54 and approved shop drawings.

(a) Drips for the removal of condensate should be installed as required. Drips should be installed in accordance with NBFU No. 54.

(b) Cut pipe must be reamed and all burrs removed before threading.

(c) Clean, sharp cut, undamaged threads of sufficient length produce tight joints.

(d) Check the thread joint compound to verify it is an oil and graphite, or graphite compound. Properly cut threads require lubrication when being pulled up to produce tight joints. Sealing compound should not be permitted. Application of oil and graphite compound should be to the male thread only to prevent the compound from being forced into the pipe line.

(e) Pipes should be supported by approved adjustable hangers. Check spacing of hangers and adjustment to grade of line.

(f) Inspect gasburning units that are adjacent to each other to ensure that a manifold is provided where required by specifications to provide a sufficient volume of gas at the same pressure for both units. The gas supply should be connected to the manifold at both ends.

(2) Installation of gas pressure regulators should be inspected very carefully. Check regulator against the approved shop drawing and for operation as required by specifications. The vent, where required, should be run to the outside of building and not discharged near a window or louver. Check adjustments of regulator to verify it delivers gas at the required pressure.

(3) Check all valves for free operation and all lubricated plug-cock types for lubrication. All valves on the gas line should be of the plugcock type.

(4) Inspect water heaters to ensure compliance with contract plans, specifications and approved shop drawings. Capacity recovery rate and temperature rise should be the same, or greater than specified. Back draft diverter should be installed to prevent pilot light from being extinguished. Check equipment and controls for American Gas Association approval label.

(5) The type and capacity of relief valves should conform to specifications. Compare the valves with specifications and determine if they comply. Inspect installation to ensure that no shutoff or check valves are installed between the relief valves as required by the specifications.

(6) Verify flues are smoketight and clear of combustible construction. Refer to NBFU No. 54 for requirements for clearance.

- (7) All piping, installation, and appurtenances for gas fired boilers should be thoroughly inspected.
- (8) Orifice jets should be checked for proper size for the gas used, altitude, etc.
- (9) Installation of gas distribution lines should be regularly inspected to determine compliance with contract and local utility requirements.
- (10) Tests should be conducted as required by contract specifications and local utility companies. Witness and observe all tests.

3.32 **Roads** (CSI Division 2)

A. Preparation of Road Beds

(1) General

Proper compaction of road and parking area subgrade and embankment are necessary to ensure that the remainder of work will be placed on a foundation that will adequately support the base course and surface course.

Ensure that geotechnical fabric meets contract specifications and is installed according to manufacturer's recommendations. If this fabric is to be installed on the subgrade prior to placement of the appropriate base material, verify that the fabric conforms to the requirements of plans, specifications and approved submittals.

(2) Advance Checks

(a) Prior to starting work, inspect the project area for construction requirements such as clearing, grubbing and stripping location, and extent of cut and fill areas, and nature of soils.

(b) Determine that Contractor's layout of work complies with specification requirements. Be familiar with required grades.

(c) Be familiar with drainage features and all embedded items that already exist or are to be installed.

(d) Know soil and compaction requirements for work in cut and fill areas.

(3) Checks During Construction

- (a) Verify Contractor work for clearing, grubbing, stripping, excavation, backfilling, and spoiling in

cut areas; and embankment construction and compaction in fill areas in accordance with contract requirements.

- (b) Verify that materials encountered are the same soils classification as those indicated on contract drawings. If not, notify the Construction Manager for appropriate action.
- c) Verify that suitable material from excavations is used to construct the grade.
- d) Verify excavation provides positive drainage from the excavated area.
- (e) Pockets of soft, yielding or otherwise unsuitable material should be replaced with suitable material.
- (f) Ensure embankments are constructed in the specified layer thickness utilizing suitable material and compaction effort.
- (g) Verify surfaces in cut areas are being compacted to obtain the specified density.
- (h) Verify that subgrade meets grade and surface tolerances.
- (i) If subdrains are required, verify they are being installed at locations and grades shown or specified.
- (j) Verify trench backfilling is being performed using satisfactory materials compacted in specified layer thickness and as required by the contract.
- (k) Verify that compaction testing of subgrade materials are performed in accordance with specifications.
- (l) Require additional tests when there is any doubt.
- (m) Verify that test results indicate that materials meet specification requirements. If not, take action to have Contractor correct any deficiency.
- (n) Ensure test results are documented with written reports.

3-58

(4) Subbase and Base Courses

(a) Advance Checks

- 1) Know requirements of base course materials to be used and maximum and minimum

compacted layer thickness permitted.

- 2) Know compaction requirements for the base course material and equipment to be used.
- 3) Be familiar with the types of base courses and the thickness required.
- 4) Know the grades to which base courses are to be constructed.
- 5) Verify the location and nature of all utilities and drainage structures in place or to be constructed. Plan to have offset reference stakes set so that position of utilities may be determined after installation.
- 6) Review test results of approved samples submitted for the project.
- 7) Check with the Construction Manager on status of materials approved and obtain copies of approval documents.

(b) Inspect approved sources of material.

- 1) If material is "bank-run" be sure the borrow pit is stripped of all unsatisfactory overburden to ensure availability of uniformly acceptable material.
- 2) If "bank-run" materials are to be stockpiled, check that stockpile area is cleaned and leveled as required, and that proposed methods of stockpiling are satisfactory.
- 3) If material is plant processed, inspect plant and determine that processing, handling and stockpiling methods will produce uniformly acceptable material.
- 4) Ensure borrow pits are finished or dressed in accordance with the specification.

(c) Record all equipment brought on the site by the Contractor. Include type, make, condition and presence of safety items.

1) Verify that safety items on equipment are operable.

(d) Base course materials may be furnished in two or more size groups and blended by means of a mixing process.

(5) Checks During Construction

(a) Hauling and Spreading

1) Spreading must be carefully controlled to minimize segregation and to attain complete and uniform coverage.

2) Check layer thickness for compliance with specifications.

3) Ensure compaction of each layer of subbase and/or base course as specified.

4) If compaction equipment does not produce the specified results, advise the Construction Manager.

5) Check for ruts or soft-yielding spots (pumping) produced during rolling. Action must be taken to correct such weak spots either through stabilization procedures or removal and replacement of material.

6) Water or aeration may be required to obtain optimum moisture content and maximum compaction.

(b) Specifications usually cover special procedures necessary for the soil type used.

(c) Check surface tolerances of each layer of the base course.

(d) Ensure that specified width of shoulder is placed and compacted at edges of each layer of subbase and base course.

3.33 **Bituminous Prime Coat** (CSI Division 2)

A. General

An asphalt prime coat may be required prior to additional surface treatment. Priming is to penetrate the surface to plug capillary voids,

coat and bond dust and loose mineral particles, and stabilize the surface and promote adhesion.

B. Advance Checks

- (1) Verify bitumen material for the prime and tack coat complies with viscosity or approved submittal.
- (2) Determine rate of application of bitumen for both prime and tack coats.
- (3) Know requirements for application and storage of the bitumens.
- (4) Review methods of measurement of and pavement for prime and tack coats.
- (5) Verify that distribution equipment conforms to the requirements for proper heating and circulation of bitumen, control of spreading rate and uniformity of application, and is equipped with accurate measuring and indicating devices.
- (6) Inspect base and/or pavement course to verify that it is clean and free of foreign material or water.
- (7) Check temperature and weather outlook to ascertain that bitumens will be applied in accordance with weather limitations of specifications.

C. Checks During Application

- (1) Weight bills and delivery tickets must accompany each delivery and should be checked to verify that required and approved bitumen is being applied.
- (2) Continuing checks should be made on functioning of distributor and other equipment.
 - (a) Rate and temperature of bitumen application must be as specified and uniform.
 - (b) Verify prime coat completely seals surface voids without a surplus remaining on the surface after the curing period.
 - (c) Take prompt corrective action in the event of unsatisfactory distribution.

- (3) Ensure that the bitumens have adequately cured. Cure time is generally about 48 hours.
- (4) Ensure that area to be primed or tacked is protected prior to and during paving operations.
- (5) Record quantities of bitumens used each day.

3.34 Hot-Mix Asphaltic Concrete and Bituminous Road Mix Surface Course (CSI Division 2)

A. General

Most projects will be located in an area where the Contractor can obtain prepared and mixed bituminous surfacing material by trucking from an established plant. This may require off-site inspections to obtain material that will meet requirements of the specification. Paving, like other phases of road work, is specialized and the services of the Construction Manager should be utilized if there are any doubts as to the materials and/or workmanship.

B. Material and Approval

- (1) The specifications require that a job mix formula be furnished to the Contracting Officer for approval. The job mix will give the percentage of aggregate for each sieve size, and the percentage of bitumen in the completed mixture.
- (2) Should the Contractor start placement of the bituminous materials prior to receipt of the approved job mix, the Inspector will advise the Contractor in writing that the material has not been approved and that if placement is continued, it is at his own risk. Also, that if the materials or job mix fail to meet requirements, the materials in place will have to be removed and replaced with materials meeting specification requirements at the Contractor's expense.
- (3) The source of aggregate used in the mix must be the same as the source of aggregate from which the job mix was determined.
- (4) Aggregate gradation must be checked periodically to determine conformance with approved material gradation.
- (5) Bituminous courses shall be constructed only when the surface is dry and rain is not imminent. Surface courses should not be placed when atmospheric temperature is below the specified temperature, unless approved by the Construction Manager.

- (6) Check lines and grades for conformance with drawing and specifications.
- (7) Check temperature of hot mix for compliance with requirements.

C. Placing and Windrowing Aggregate

(1) There are two general methods of mixing aggregates with asphaltic materials directly on the location where the mixture is to be laid and compacted. They are as follows:

(a) By blading and dragging. This method is generally not permitted except on very small jobs.

(b) Traveling plant method.

(2) Inspect the pavement mixture before spreading to determine whether or not mixing is complete. If the mix is not satisfactory inform the Contractor about corrections.

D. Spreading and Shaping

After the bitumen and aggregate have been satisfactorily mixed and approved by the Inspector, it should be spread by a mechanical spreader in accordance with specification requirements, and to final line grade and section shown on contract drawings.

Immediately after any course is placed, before roller compaction is started, the surface should be checked, and any inequalities adjusted. Irregularities in alignment and grade along the outside edge should be corrected by the addition or removal of mixture before the edge is rolled. At deep or irregular sections, intersections, turnouts or driveways where it is impractical to spread and finish the base, leveling or surface mixtures by machine methods, approved spreading equipment or acceptable hand methods should be used.

E. Rolling Finished Surface

After each layer has been satisfactorily spread, the surface shall be rolled. A tack coat between layers may be required. Final rolling shall be done by means of smooth faced power-driven rollers. Power driven tandem and three-wheel rollers should be in good condition, capable of reversing without backlash. They should be kept in continuous operation as nearly as practicable in such a manner that all parts of the pavement receive substantially equal compression.

The speed of the roller should not exceed three miles per hour and should at all times be slow enough to avoid displacement of the surface course. Any displacements occurring as a result of reversing the direction of the roller, or from any other cause, should be corrected immediately.

Rolling should proceed in a longitudinal direction, beginning at the outer edges and working toward the center. Each trip should overlap the prior trip by one-half the width of the roller. Rolling should proceed continuously until all roller marks are eliminated and no further consolidation is possible. If the surface course tends to adhere to the rollers, they should be kept properly moistened. Excess of either water or oil should not be permitted.

F. Samples

Samples should be taken and tested as required by the contract specifications.

G. Smoothness Test

The finished surface should be free from depressions exceeding 1/4inch as measured with a 10-foot straight edge paralleling the centerline of the paved area, or at right angles to the centerline. The Inspector will test for conformity with the specified crown and grade immediately after initial rolling. Any variation from required crown, grade or smoothness should be corrected by removing or adding materials and continuing the rolling. After the rolling is completed, the smoothness should again be checked, and any deviations corrected by removing compacted areas and replacing asbestos cement to the proper grades.

3.35 **Water Well Drilling** (CSI Division 2)

A. General

The overall process of water well drilling is a specialty that requires inspection by experienced personnel.

B. Siting

The selection of a well site will be made by the project engineer. Check location of wells in the field against contract drawings and location of local service controls.

C. Drilling Equipment

The two general types of drilling rigs are cable tool and rotary drill. The contract may require the use of one type or give an option. A cable tool rig consists of a heavy drill bit connected to free running wire cables with cutting action accomplished by gravity dropping of the bit and subsequent lifting by cable. The rotary drill bit consists of a set of wheel cutting devices attached to a rotating shaft, and uses drilling mud as a lubricant and stabilizer to keep the hole open as drilling progresses. A few rotary rigs are equipped with a percussion hammer for driving the casing (like a cable tool rig). Determine that the Contractor is furnishing the type of rig required, that its condition and appurtenant equipment are good, and the driller's platform is strong and well supported to carry the weight of the equipment.

D. Starting and Drilling the Well

The hole may be drilled from the start to accommodate the casing or it may be started with a small hole and reamed later for the casing. The starting of the well hole is known as "spudding in." It is important that the hole be started straight and from then on the Inspector must check the alignment for plumb. If the cable or shaft shows wear or shiny sections, it is probable that the hole is not plumb. The remainder of the inspection for this portion of the work is observation and accurately recording all observations and data obtained from the drilling. The recordings and log are covered in Section 3.35L.

E. Casing

The general practice is to use a casing to prevent caving during and after completion of a well. Casings are also used to seal off surface or ground water which might contaminate the well. A larger casing is generally used at the beginning of the well at ground surfaces, and is reduced in diameter as the well drilling proceeds. The varying sizes of casing to be used are given in the specifications. Specifications must be followed in all respects, particularly sizes and lengths of various size casings to be used. The size and lineal foot of various size casings usually constitute a "pay item" for the Contractor, and a careful record should be kept and reported. Domestic wells, 4" and 6" diameter, normally use one size casing with a well screen placed at the bottom of the hole.

F. Perforation of Casing and Well Screens

Opposite the strata containing water of a quality suitable for planned use, the casing must either be perforated or replaced by a well screen to

permit free entrance of the water into the well. Perforations can be made in the field, if permitted by the specifications; otherwise, machine cut perforated casing is available from the factory. Field perforating can be done before placement by punching or by cutting slots with any acetylene torch. In-place perforation can be made with a well knife or well perforator. Well screens are often inserted as casing sections to provide for water entry. These are available in various designs, diameters, slot sizes, and corrosion-resistant metals. Well screens are particularly advantageous in sandy aquifers as here the screen opening can be selected to filter out sand exceeding a certain size. On wells requiring screens the Contractor is required to send samples of the water-bearing stratum and a copy of the well log to a screen manufacturer for analysis and recommendations. Those recommendations must be approved by the Contracting Officer before installation of the well screen is permitted.

G. Gravel Packine

A gravel-packed well is one containing a gravel envelope surrounding the perforated portion of casing or well screen. The gravel increases the effective well diameter, acts as a strainer to keep fine material out of the well, and protects the casing from caving of surrounding formations. Thickness of the gravel layer will vary with the type of formation and method of drilling. Careful selection of the gravel size is important if sand is to be held back at the outer edge of the pack. In wells containing screen and gravel pack, gradation of the gravel is in accordance with approved gradation and is installed to the depth required by the specifications, normally several feet above the top of the well screen.

H. Development

Development is an essential operation in the proper completion of a water well which brings it to maximum available capacity by unclogging the formation which occurs as a side effect of drilling operations. Every method of well drilling plugs off the pores of the water bearing formation in varying degrees, and rotary drilling with mud fluid effectively seals off the bore hole. Development work stabilizes the sand formation around a screened well by removing the finer particles to increase the porosity of the formation. This also applies to gravel packed wells.

There are several methods for developing a well, and the most common is surging and bailing. A heavy bailer, which is a steel cylinder with a one way valve, is moved up and down inside the casing or bore hole. On the down stroke it forces water out of the well, and on the upstroke

a negative pressure is created thereby pulling water and fines into the well. Surging and bailing continues until the amount of particles entering the well diminish to an acceptable level and the water becomes clearer.

Other methods of developing include; surge plunger, valve type plunger, surging with air, jetting with air, jetting with water, pumping, and explosives. The choice of method is usually made by the well driller who knows which method will give the best results for formations in that area.

I. Pumping Test

The pump test determines the yield of the well and is used to select a permanent pump that is sized to meet water requirements and not exceed the well's yield. The critical elements of a pump test are accurate measurements from the top of the well to the water level inside the casing; before the test, during the test, and after pumping has ceased. Also, accurate measurements of gallons per minute being pumped, and that the pump test is continuous for length of time specified and without interruption. If the pump test is interrupted for any reason, power failure, engine failure, etc., the test should be repeated after the well has rested and the static water level returned to original elevation.

J. Grouting

Grouting the well casing involves filling the space around the pipe, usually between the well casing and the bore hole. If the well construction includes both an inner and outer casing, grout may be placed between the two casings in addition to sealing outside the outer casing. Grout normally consists of a mixture of portland cement and water, and the payment item is per bag of cement. The Inspector should closely observe the number of bags delivered on-site and collect empty bags on an interim basis for payment computations.

K. Finished Well

After it has been determined that quantity and quality of water meets specification requirements; and chemical treatment has been used to clean out all driller's mud; well has been disinfected; and water has been analyzed per contract requirements, the well should be measured and capped. Temporary capping during the construction period must be required at all times when work is not active. Wells may be ordered to be abandoned by the Contracting Officer. All abandoned wells should be located topographically so that the exact site can be easily reestablished. Some States require that abandoned wells be permanently closed by grouting the entire well.

L. Daily Log

- (1) For water wells, record the following information in the Daily Log.
 - (a) Weather.
 - (b) Beginning and completion of work and length of time required for each particular operation, i.e., obtaining specific formation samples.
 - (c) Progress.
 - (d) Lineal feet and size of casing used.
 - (e) Delivery of materials.
 - (f) Obstacles encountered by Contractor.
 - (g) Formations encountered (if known).
 - (h) All adverse difficulties.
 - (i) All directives and/or recommendations made by Construction Manager.
- (2) The Inspector must be especially attentive to the following items:
 - (a) Record depth and sample all change of formation.
 - (b) Classify all materials in field and record depths.
 - (c) Keep constant record of all water depths - record loss or gain.
 - (d) If any gain in water, record depth, run bailing test, and obtain rate of water increase.
 - (e) Every time well is left for a few hours, read water level when leaving and again when work is resumed.
 - (f) When the well is dry - record this information.
 - (g) Observe and record position and thickness of caving strata.

(h) Pay particular attention when entering sandstone or gravel.

(i) Record driller's opinions of material, etc., along with Inspector's opinions.

(j) Do not ignore as little as six inches of sand with a trace of water. It may be that sufficient water can be developed from it, especially if rotary drill is being used. The Inspector is cautioned to thoroughly test for quantity of water available in these cases before proceeding with deeper drilling.

M. Comments of Caution

(1) Check procedures for sampling of formation, depth at which obtained, that continuous sampling is performed, that representative samples are obtained and that each sample is packaged and labeled properly.

(2) Check that boring log is kept for each hole.

(3) Check cleaning of bore hole.

(4) Check that screens are of type approved by the Contracting Officer, correct metal, gauge and screen openings for size, shape, pattern and spacing.

(5) Gravel pack - Check type of material, gradation, cleanliness, etc.

(6) Check method used for placement of screen.

(7) Check that site cleanup is completed before Contractor leaves project site.

(8) Write a complete memorandum to the Construction Manager indicating final measurement of all pay items after well is completed and furnish test pumping and recovery records.

4.0 SAFETY

4.1 Purpose

This chapter provides procedures and guidance Service personnel shall follow to ensure that safety is adequately addressed in contracted construction activities. Roles, responsibilities, and requirements of Service personnel and

Contractors are provided relative to compliance with regulations established by the Occupational Safety and Health Administration (OSHA) at 29 CFR 1926 and 1910.

Contractual language between the

Service and the Contractor binds the Contractor to comply with applicable OSHA regulations/standards until the contracted work has been finalized and accepted by the Contracting Officer.

The primary purpose for mandating such compliance is to make sure that no Contractor requires an employee working in the performance of the contract to engage in on-site work under conditions that are unsanitary, hazardous, or dangerous to their health or safety. Additional information or clarification regarding the following requirements and procedures may be obtained by contacting a Regional Safety or Engineering Office.

4.2 General

A. Construction safety is directly dependent upon the Contractor's planning and work efforts. For all contracts involving work of a hazardous nature (e.g., explosives, demolition, hazardous wastes, scaffolding, derricks/cranes) or when the Government technical representatives advise that special safety precautions are appropriate, the Contractor is required to evaluate the scope of the construction project; complete a pre-construction safety checklist (Exhibit 7.6); and prepare an appropriate safety plan in accordance with Alternate I of the FAR Accident Prevention Clause, 52.236-13. The Contracting Officer (CO) and the Contracting Officer's Representative (COR), in coordination with the Regional Safety Manager, shall work together as a team to determine the need for and evaluate the submitted plan.

The Contractor's pre-construction safety checklist is used for assessing contractor safety and health considerations of the project. The checklist should be addressed by the Contractor and the checklist items recorded by the CO/COR at a pre-construction conference if such a meeting (either on-site or by telephone) is determined to be necessary by the CO. In these cases, the CO/COR shall provide the assigned CI with a copy of the completed checklist before the Contractor begins work.

Prior to commencing work on all projects involving work of a hazardous nature or life safety code factors, the Contractor must submit the required safety plan (per Alternate I of FAR Accident Clause, 52.236-13) to the CO for acceptance through a review process by the COR and/or Regional Safety Manager. If a submitted plan is deemed unacceptable during the review process, the CO shall notify the Contractor of the decision and request a resubmittal to address noted concerns. The Contractor's plan must provide specific measures for controlling potential or known work hazards and comply with contract safety regulations. For plans deemed acceptable, the CO shall notify the Contractor of its acceptance. A copy of the Contractor's accepted safety plan shall be provided to the CI by the CO/COR. Acceptance of the Contractor's safety plan does not relieve the Contractor of the responsibility for providing a safe, healthful environment and complying with all contract requirements, applicable laws and regulations.

4-1

The CI and Contractor must review and understand the prescribed contract safety requirements before the start of any work. A meeting for this purpose should be mutually arranged and conducted by the CI with the Contractor. During the meeting, the CI should ascertain from the Contractor the person they have designated as administering their on-site safety program. A review of the pre-construction checklist, accepted safety plan, and other safety considerations should be discussed in the meeting. The results of the meeting should be recorded in the CI's Daily Log.

B. If at any time during construction the CI recognizes a condition, method or practice which constitutes an imminent danger* to Contractor employees, Service personnel, and/or members of the visiting public, the Contractor shall be advised to remove affected persons from the hazard/area. The Contractor shall then implement necessary corrective

actions required to bring the dangerous condition (e.g., work method, practice, process, etc.) into compliance. If necessary as described below, the CO will suspend that portion of the work where the danger exists until the imminent danger is eliminated. The CO/COR shall be notified immediately by the CI. The CI may only issue a suspension-of-work order in the following manner/situation:

If the CO cannot be reached to officially stop a condition of imminent danger*, the CI must document the unsafe condition with the form letter provided in Exhibit 7.4, and stop the Contractor from proceeding with any work related to the unsafe condition. The unsafe condition should be documented with photographs. The COR and CO must be notified of the action taken as soon as possible due to possible contractual concerns. A CI initiated suspension-of-work could occur when a Contractor has been cleared to work overtime after normal hours, or on weekends when a CO/COR may not be readily available.

*Imminent danger as defined by OSHA is "any conditions or practices in any place of employment which are such that a danger exists which could reasonably be expected to cause death or serious physical harm immediately."

If any unsafe condition at the construction site places visitors or Service personnel at risk, the COR/CI shall require the Contractor to take immediate steps to eliminate the condition. Significant actions taken by the CI regarding safety shall be recorded in the Daily Log. The CO/COR shall be notified as appropriate.

4.3 Accident/Incident (Reporting and Investigating)

The Contractor has primary responsibility for reporting and investigating an accident/incident involving Contractor employee death, lost-time injury, or property damage/loss of \$2,500 or more arising out of work performed under the contract. The Contractor is responsible for providing and obtaining appropriate medical and other emergency assistance needed as a result of the accident. The Contractor must immediately notify and provide a brief description of the situation to the CO/COR/CI and the Service manager of the field station. Accidents/incidents involving Service personnel, Government property, or members of the visiting public shall also be reported to the CO/COR/CI and the Service manager of the field station. Contracting Officers need to be cognizant of third-party liability issues regarding property damage or injuries caused by Contractors.

The Contractor shall investigate all reported work-related accidents/incidents to the extent necessary to determine their cause(s) and furnish the CO an investigative report outlining findings and proposed or completed corrective actions. The CO shall consult with the COR, CI, and Regional Safety Manager in reviewing the investigation report

4-2

and corrective actions. If the Contractor fails or refuses to institute prompt corrective action, the CO may invoke the contract's Suspension-of-Work clause or any other remedy available to the Government. Except for rescue and emergency measures, the scene of an accident/incident shall not be disturbed or the operation resumed until the on-site investigation has been completed.

Service safety personnel and representatives from Federal, State, and local government agencies may have the right to examine the accident or construction site to assess the Contractor's investigation/findings or determine the adequacy of the Contractor's safety and health plan.

The COR/CI shall ensure that a Safety Management Information System (SMIS) electronic accident/incident report is completed by an employee of the involved Service facility as soon as possible after the accident/incident. SMIS reports are completed online at <http://www.smis.doi.gov>. Contact the appropriate Regional Safety Office for additional assistance.

All significant actions, oral or written, taken by the CI regarding an accident/incident shall be recorded in the Daily Log.

4.4 Training

Training requirements for the COR are specified in the Department of Interior Acquisition Regulation (DIAR) 1401.670-3, Certification Requirements. The DIAR training requirements also apply to any individual acting as an authorized Service representative in the administration of the contract, including the CI. Prior to performing construction inspection duties, CORs/CIs are also required to successfully complete the Service's Construction Safety Training Course provided on the Internet at <http://training.fws.gov/safety/construction.html> (course instructions are provided at this address), or one of the following OSHA Training Institute/Education Center's construction safety courses - Nos. 200, 200A, 500, or 510. Contact the Regional Safety Office for additional information about these courses.

4.5 Compliance with Federal, State and Local Laws

The Contractor is, by terms of the contract, required to comply with applicable provisions of Federal, State and Local safety/health/sanitation/construction laws and codes. In the event of a conflict between Service safety and health requirements and OSHA or other applicable Federal, State or local regulations, the more stringent provision shall prevail.

Representatives from Federal, State, and local safety agencies and Service safety personnel are authorized to conduct inspections and investigations. The Contractor and CI shall cooperate with such representatives in requiring compliance of safety and health laws and regulations applicable to the contracted work.

The CI should not hesitate to contact the CO, COR, or Regional Safety Office for assistance in handling safety and health compliance issues, particularly when the Contractor refuses to adhere to applicable safety and health requirements.

4-3

4.6 Safety Guidelines

The construction safety information in this Handbook is to be used as a guide for incorporating safety in Service construction projects. This information is not intended to be all-inclusive or to replace and/or modify any OSHA or other applicable standards. The primary applicable standards are OSHA's Construction Industry Safety and Health Standards (29 CFR 1926) and General Industry Standards (29 CFR 1910).

The COR/CI are encouraged to use the latest edition of OSHA publication #2202 "Construction Industry Digest" and publication #2201 "General Industry Digest" as guides for ensuring compliance with OSHA standards.

5.0 FINAL INSPECTION

5.1 General

The guidance in this chapter is intended for those projects of sufficient complexity to require a formal final inspection. Final inspection is to determine if the work accomplished and the materials and equipment furnished comply with specification requirements. Final inspections are usually conducted in two phases: 1) a pre-final inspection, and 2) a final inspection. The pre-final inspection is conducted by the CI. The final inspection is conducted by the CI and COR assigned to the project (who may be accompanied by the A/E and CO).

5.2 Scheduling the Final Inspection

A. Upon receipt of a request from the Contractor for a final inspection, the COR will immediately contact the CI and the Contractor to determine whether the project will be ready for final inspection on the date requested. At that time, the CI will conduct the pre-final inspection to verify that the project is ready for final inspection.

B. If the CI agrees that the date schedule is realistic, the COR will advise the Contractor and make all arrangements with the inspection team.

C. After final inspection, the decision to accept a project as substantially complete or for beneficial

occupancy is made only by the CO based on recommendations by the CI and COR.

5.3 Pre-Final Inspection

The pre-final inspection serves a dual purpose: 1) determination of readiness of project for final inspection, and 2) preparation of a Deficiency or Punch List (see Exhibit 7.2). To assist with this, the following “pre-final Inspection Checklist” should be used. This list includes those items most commonly found on deficiency list, but is not all-inclusive.

Do not rely upon memory alone. Perform all inspections with project plans and specifications readily available to confirm your findings using this Checklist as a guide.

A. Architectural Items

1. Doors, including hardware, finish, door stops, etc.
2. Windows, including hardware and finish
3. Paint (touch-up as necessary)

5-1

4. Tile, ceramic (clean and seal around fixtures)
5. Tile, vinyl, etc. (clean, wax and polish, repair or replace)
6. Rubber base (fit, refasten, or replace)
7. Drywall (patch cracks, holes, etc.)
8. Masonry (check mortar joints, etc. point as necessary)
9. Metal trim (check for sharp edges, finish, etc.)
10. Millwork, cabinet doors and drawers, counter top (fit, paint, etc.)
11. Floor hardener as required
12. Key identification
13. Tar runs on fascia gravel stop
14. Recaulk as required
15. Suspended (gypsum board) ceilings
16. Roofing
17. Cleanup as necessary

B. Mechanical

1. Adjust fixtures
2. Clean fixtures/equipment
3. Check for leaks
4. Check for missing accessories
5. Test appliances
6. Install missing escutcheons, floor and wall plates, etc.

7. Check cleanouts, chrome covers plates, etc.
8. Check floor drains

C. Electrical

1. Straighten switch plates and outlet covers
2. Provide circuit directory in panels and verify
3. Check fixtures and test for secure hanging
4. Proper electrical service to each electrical item
5. Operate all lights and equipment
6. Check weatherhead, mast size, etc.
7. Clean meter base, disconnect switch, etc.
8. Check grounds
9. Clean panel interior/touch up-paint on exterior

5-2

D. Heating and Ventilating

1. Adjust registers, louvers, grilles, etc.
2. Test equipment
3. Test controls
4. Require and observe all tests and provide test records
5. Provide instructions, manufacturers data as required
6. Check flues

E. Distribution System

1. Water

- a. Valve boxes, fire hydrants, check grades and locations.
- b. Provide wrenches and valve keys
- c. Storage tank installation, repair, painting, etc.
- d. Check gages, meters, etc., as required
- e. Observe all tests required

2. Sewer

- a. Check manhole grades
- b. Check slopes and grades on ponds and dikes
- c. Check cleanouts
- d. Pump all lines

3. Gas, Liquified Petroleum

- a. Check pressure regulators, piping and connections

b. Tank, installation, paint, anchors, etc.

F. Site Work

1. Check fine grading and drainage
2. Check grades on curbs, gutter, etc.
3. Concrete sidewalks, repair or replace as required
4. Fencing
5. Roads and driveways, required compaction, etc.

G. General

1. As-built drawings
2. Record names of Service personnel given operation/maintenance instructions.

5-3

6.0 LABOR RELATIONS

6.1 General

This chapter deals with the scope and application of those labor standards and provisions which apply most directly to the CI's enforcement role. The role of the CI is imposed by law; it is fundamental to the success of the program and its importance is widely demonstrated in practice. Responsible project personnel are to be guided in the discharge of their enforcement responsibilities by this Section. Responsibility for enforcement of labor standards rests with the CO. The CO is responsible for all payroll and compliance reviews. However, the CI functions the CO's ears and eyes on the project site.

6.2 Labor Standards Interviews

The CI should conduct periodic labor standards interviews of employees on the project. The Labor Standards Interview form (Exhibit 7.3) should be used. After completion of each interview, the form should be forwarded to the CO through the COR. The CI should randomly select a representative sample of on-site workers to interview from the various trades as well as from the various subcontractors and prime Contractor.

6.3 Violations of Labor Standards Provisions

If the CI suspects a labor standards violation or is approached by an employee concerning a violation, this information should be transmitted to the CO for further investigation. Following are examples of the most frequently encountered violations.

A. Overtime pay. Failure of the Contractor to pay 1.5 times basic pay for work performed in excess of 40 hours per week.

B. Prevailing Wage rate. Paying employees at a rate less than the wage rate shown in the contract. Pursuant to Labor Standard Provisions, the Davis-Bacon Act itemizes the minimum hourly rates to be paid to laborers and mechanics for work performed on-site. (Minimum wages rates must be posted at the job site in a prominent place where they can be easily seen by workers.)

C. Classification. Paying employees at a rate less than that for the proper classification of work performed (e.g., paying the laborer rate when work performed is that of a carpenter or some other classification).

PUNCH LIST

[illegible]

LABOR STANDARDS INTERVIEW			FORM APPROVED OMB NO. 9000-0089	
CONTRACT NUMBER		EMPLOYEE'S NAME (Last, First, M.I.)		
NAME OF PRIME CONTRACTOR		EMPLOYEE'S ADDRESS (Street, City, State, ZIP Code)		
NAME OF EMPLOYER		WORK CLASSIFICATION	WAGE RATE	
		SUPERVISOR'S NAME (Last, First, M.I.)		
			(Check Below)	
DO YOU WORK OVER 8 HOURS PER DAY?			YES	NO
DO YOU WORK OVER 40 HOURS PER WEEK?				
ARE YOU PAID AT LEAST TIME AND A HALF FOR OVERTIME HOURS?				
ARE YOU RECEIVING ANY CASH PAYMENTS FOR FRINGE BENEFITS REQUIRED BY THE POSTED WAGE DETERMINATION DECISION?				
WHAT DEDUCTIONS OTHER THAN TAXES AND SOCIAL SECURITY ARE MADE FROM YOUR PAY?				
HOW MANY HOURS DID YOU WORK ON YOUR LAST WORK DAY BEFORE THIS INTERVIEW?				
HOURS	WHAT DATE (YYMMDD) WAS THAT?			
WHAT TOOLS DO YOU USE?				
WHEN DID YOU BEGIN WORK ON THIS PROJECT (YYMMDD)?				
I HAVE READ THE ABOVE AND CERTIFY IT TO BE CORRECT TO THE BEST OF MY KNOWLEDGE.				
EMPLOYEE'S SIGNATURE			DATE (YYMMDD)	
INTERVIEWER'S SIGNATURE			DATE (YYMMDD)	
INTERVIEWER'S COMMENTS				
WORK EMPLOYEE WAS DOING WHEN INTERVIEWED				
IS EMPLOYEE PROPERLY CLASSIFIED AND PAID? (If additional space is needed, use comments section)				
<input type="checkbox"/> YES <input type="checkbox"/> NO				
ARE WAGE RATES AND POSTERS DISPLAYED?				
<input type="checkbox"/> YES <input type="checkbox"/> NO				
FOR USE BY PAYROLL CHECKER				
IS ABOVE INFORMATION IN AGREEMENT WITH PAYROLL DATA?				
<input type="checkbox"/> YES <input type="checkbox"/> NO				
COMMENTS				
DATE OF CHECK (YYMMDD)	NAME OF CHECKER (Last, First, M.I.)	JOB TITLE	SIGNATURE	

NBSN 7540-01-266-0832
GPO: 1987 300-488 (M)

1445-101

STANDARD FORM 1445 (10-87)
Prescribed by GSA
FAR (48 CFR) 53.222(g)

(Date)

(Time)

Contractor's Superintendent

Contractor's Name

Address

Contract Number

Station

Project

This letter is used only when an unsafe condition is judged so severe that it could cause death or severe physical harm, if not remedied immediately.

You are hereby notified that I consider the following condition to fall within the definition of the preceding sentence.

Unsafe condition description: _____

You are directed to immediately stop all portions of the work related to the above condition(s). I am in the process of notifying the Contracting Officer of this condition for appropriate action.

This notice is a part of the official contract file.

cc: Contracting Officer
Construction Manager
Safety Office

On-site Government Representative

EXHIBIT 7.4

TIME AND MATERIALS REPORT

The Time and Material (T&M) Report should be used by the Inspector as an aid in documenting additional work by the Contractor that is related to but is not a part of the original contract. Example: An existing 10-inch water line is encountered at a location conflicting with the drawings for a new building's foundation. The Contractor is directed to relocate the water lines outside of the new building's perimeter. On the T&M Report, the Inspector should record the date, manhours, skill levels, equipment and materials used by the Contractor in performing the work (see attached blank form and sample form). The Inspector and the Contractor's Superintendent should sign the report with copies retained by the Contractor and the Construction Manager.

Accurate recordkeeping and reporting are essential in avoiding contract disputes and claims. A T&M Report for all additional work is required for the contract record.

U.S FISH AND WILDLIFE SERVICE

DENVER ENGINEERING CENTER

TIME AND MATERIALS WORK SHEET

STATION _____ PROJECT _____

DATE _____ 19 _____ CONTRACT NO. 14-16-000 ____ - _____

DESCRIPTION	RATE \$/	HOURS	TOTAL
LABOR			
EQUIPMENT			
MATERIALS	QUANTITY	UNIT PRICE	
USFWS ON-SITE REPRESENTATIVE	TOTAL TODAY		
BY _____	ACCUMULATIVE TOTAL		
CONTRACTOR	TOTAL-TO-DATE		
BY _____			
10/16/86			

U.S FISH AND WILDLIFE SERVICE

DENVER ENGINEERING CENTER

TIME AND MATERIALS WORK SHEET

STATION _____ PROJECT _____

DATE _____ 19 _____ CONTRACT NO. 14-16-000 _ - _

DESCRIPTION	RATE \$/	HOURS	TOTAL
LABOR			
CARPENTER			
LABOR			
LOADER OPERATOR			
BACKHOE OPERATOR			
TRUCK DRIVER			
FOREMAN			
EQUIPMENT			
BACKHOE			
BACKHOE/LOADER			
FRONT END LOADER			
DUMP TRUCK 10/12 YD			
DUMP TRUCK 5/6 YD			
OTHER			
MATERIALS			
CONCRETE FORMS	QUANTITY	UNIT PRICE	
REINFORCING			
CONCRETE			
MISCELLANEOUS METALS			
ROOF STRUCTURE			
PIPE AND FITTINGS			
OTHER			
USFWS ON-SITE REPRESENTATIVE			TOTAL TODAY
BY _____			ACCUMULATIVE TOTAL
CONTRACTOR			TOTAL-TO-DATE
BY _____			
10/15/86			

PRE-CONSTRUCTION SAFETY CHECKLIST - EXHIBIT 7.6

PROJECT TITLE:	CONTRACT NUMBER:	PROJECT LOCATION:
PRE-CONSTRUCTION MEETING DATE:	NAME AND ADDRESS OF CONTRACTOR:	NAME OF CONTRACTOR SUPERINTENDENT/FOREMAN
NAME OF SERVICE CONTRACTING OFFICER:	NAME OF CONTRACTOR'S COMPETENT PERSON (PER 29 CFR 1926.31):	PROPOSED CONSTRUCTION START DATE:

The Fish & Wildlife Service (FWS) places safety and health as a top priority at all Service contracted construction sites (360 FW 4). The Contractor has ultimate responsibility for safety during construction until final completion and acceptance of the project by FWS.

This checklist serves as an assurance tool/guide in assessing safety program preparations of the contractor, and is not all-inclusive. As tasks change and new risks and hazards are introduced, you may need to address additional safeguards and corrective measures.

The Contractor and subcontractor(s) must comply with all Occupational Safety and Health Administration (OSHA) regulations applicable to the construction project, including requirements set forth within solicitation provisions and contract clauses (e.g., FAR 52.236-13 "Accident Prevention" with Alternate I and Special Provisions). It is the responsibility of the contractor/subcontractor(s) to adhere to regulations found at 29 CFR 1910, 1926, and 1928. (See page 5 for Table of Contents of OSHA Construction Safety Standards.) Each contractor/subcontractor must initiate and maintain an effective safety program that provides adequate systematic policies, procedures, and practices to protect their employees from, and allow them to recognize, job-related safety and health hazards. The program must include provisions for the systematic identification, evaluation, and prevention/control of general work site hazards, specific job hazards, and potential hazards that may arise from foreseeable conditions, as well as providing a competent person to conduct frequent and regular inspections. The Contractor must instruct each employee to recognize and avoid unsafe conditions and the regulations applicable to the work environment.

The Contractor will address the following items prior to and/or during the Pre-construction Conference (the Contracting Officer/Contracting Officer's Representative will record these items):

1. The Contractor has read and understands his/her responsibilities for compliance with contractual safety language - FAR 52.236-13, Accident Prevention, Alternate I and applicable safety provisions? YES ____

NO ____

2. Has Contractor prepared a Safety Plan that analyzes anticipated hazards of the project and indicates how the hazards will be controlled? Contractor must identify specific procedures for controlling hazardous operations such as crane use, scaffolding, excavation/trenching, hot work/welding, etc.,. YES ____ NO ____ N/A ____
3. How will Contractor/subcontractor address the four leading hazards of construction work: falls, struck by, caught in/between, and electrical?
-
-

4. The "Designated Competent Person" (responsible for the project's safety and health performance) is knowledgeable in applicable OSHA regulations and capable of identifying existing/predictable hazards, and has the authority to prompt corrective measures? YES ____ NO ____

5. Do Contractor and subcontractor employees know what to do in the event of an emergency (e.g., injury, fire, accident, hazardous material spill, etc.) with regard to the following actions? YES ____ NO ____

- a. Notification of Department, FWS Facility Manager, CO, COR, Construction Inspector (CI), etc.
- b. Means of communication with contact numbers (e.g., radio, cellular, pager, etc.).
- c. Availability of first-aid/medically-trained contractor personnel with appropriate medical supplies
- d. Personnel (including subcontractors) knowledge of location for immediate aid (e.g., first-aid, etc.).
- e. Evacuation routes, signals, and procedures are provided to all on-site personnel.
- f. Safety and health information disseminated to all site personnel (e.g., contractor and subcontractor employees).

6. Will a Contractor/subcontractor trailer be brought on site and its hook-up/placement coordinated with COR/CI? YES ____ NO ____ (If no, skip to # 7)

- a. Location and type of trailer (office or equipment).
- b. Telephone hook-up.
- c. Electrical hook-up.
- d. Vehicle parking arrangement (adequate space).
- e. Propane used for heating? YES ____ NO ____
- f. Serve as first-aid station? YES ____ NO ____

7. Is Contractor aware that he/she must ensure construction area is clearly delineated and posted with appropriate warning signs (e.g., "Hard Hat Area", "Construction Site – CLOSED", "Area Closed to Public", etc.), and that instructional signs (e.g., designated parking area, etc.) and flagmen or barriers may be required? Yes ____ No ____

8. Housekeeping - Is Contractor/subcontractor aware that they must ensure that following acceptable housekeeping standards are practiced from project's start to finish? YES ____ NO ____

- a. Form/scrap lumber with protruding nails and all other debris shall be kept clear from work areas.
- b. Combustible scrap and debris shall be removed at regular/frequent intervals.
- c. Materials shall be stored with regard to their fire characteristics with effective fire protection and prevention measures used.
- d. An enclosed chute shall be used whenever materials are dropped more than 20 feet to an exterior point of a building.
- e. Aisles, exits, and passageways shall be kept clear and in good repair.

9. Is Contractor aware of following Environmental and Personal Controls standards?

YES___ NO___

- a. Potable water provided.
- b. Restroom facilities provided.
- c. Washing facility provided for employees engaged in operations involving harmful substances.
- d. Intoxicating beverages, controlled substances, and/or firearms are not permitted under any circumstances on the construction site.
- c. All activities in or around water bodies must be in compliance with regulations for worker safety, including personal flotation devices or buoyant work vests, lifelines, ring buoys and guardrails while working over or adjacent to water hazards, and from barges, boats, and/or launches.

10. Is Contractor/subcontractor aware that following employee training considerations may need to be addressed?
YES___ NO___

- a. Confined Space.
- b. Scaffolding.
- c. Fall Protection.
- d. Hazard Communication.
- e. Lockout/Tagout.
- f. Respiratory Protection.
- g. First Aid.

11. Contractor/subcontractor is responsible for requiring the wearing of appropriate personal protective equipment in all operations where there is an exposure to hazardous conditions or where the need is indicated for using such equipment to reduce the hazard to their employee(s). The contractor/subcontractor is also responsible for ensuring that personnel using protective equipment are trained and medically qualified to do so. Such personal protective equipment may include the following: Discussed with Contractor? YES___ NO___
—

- a. Eye and face protection (safety goggles, safety glasses, welding goggles, face shields, etc.).
- b. Protective footwear (safety shoes, boots).
- c. Protective gloves (leather, rubber, insulated).
- d. Respirators (dust, half-face, full-face, etc.).
- e. Hearing protection (ear plugs, muffs, etc.).
- f. Coast Guard-approved PFD/buoyant vest.
- g. Fall protection equipment.

12. Tools (hand, electric, pneumatic) Standards: Discussed with Contractor? YES___ NO___

- a. Hand tools, power tools, and jacks are maintained in safe operating condition and used only for the purpose for which they were designed.
- b. Electric power-operated tools must be either approved double-insulated, or be properly grounded (see Item #13 "Electrical" for additional considerations).

13. Electrical Standards:

- a. Ground Fault Circuit Interrupters (GFCIs) or an assured equipment-grounding conductor program must be used to protect employees from ground-fault hazards.
- b. Electrical cords/insulation must be in good condition (not frayed or damaged).
- c. All ground plugs must be on electrical cords, if so designed by the manufacturer.

- d. Workspace, walkways, and similar locations shall be kept clear of electrical cords.
- e. All electrical extension cords must be of the three-wire type.
- f. Contractor/subcontractor must determine need and implement an appropriate Lock-out/Tag-out program.

14. Will motor vehicles, cranes, and/or heavy equipment be used? YES ___ NO ___ (If no, skip to #15)

- a. Crane and derrick use must comply with applicable standards.
- b. Rollover protection as required.
- c. Back-up alarms or observer signals as required.
- d. No crawler type vehicles are allowed on an improved road.
- e. All utilities must be located prior to excavating soil.

15. Excavating and Trenching work? YES ___ NO ___ (If no, skip to #16)

- a. All excavating/trenching must be in accordance with applicable safety standards.
- b. All utilities must be located prior to excavating.

16. Elevated Work? YES ___ NO ___ (If no, skip to #17)

- a. Ladders and their use must conform to standards.
- b. Aerial lift usage must meet applicable requirements.
- c. Fall protection needs must be assessed per standards.
- d. Scaffold work must conform to standards.
- e. Stair design, construction, and use must meet applicable requirements.
- f. Toeboards, when used to protect workers from falling objects, must be erected along the edge of the overhead walking/working surface.
- g. Safety net use must comply with standards.
- h. Railing must conform to standards.

17. Contractor is aware of and understands the need to incorporate applicable requirements for concrete and masonry construction. YES ___ NO ___ N/A ___

18. Contractor is aware of and understands the need to incorporate welding and cutting operations that comply with applicable safety requirements (e.g., compressed gas cylinders are protected from vehicle traffic, valve caps secured, etc.). YES ___ NO ___ N/A ___

19. Contractor is aware of and understands the need to manage hazardous materials/waste appropriately (e.g., paints, solvents, fuels, etc.) including the following:
YES ___ NO ___ N/A ___

- a. Use and storage of flammable/combustible liquids.
- b. Aboveground fuel storage tanks properly managed/contained.
- c. Compressed gases and cylinders managed correctly (e.g., secured and protected from damage, etc.).
- d. Procedures for managing use, storage, and disposal of hazardous materials properly established.
- e. Excess/waste product(s) and containers properly disposed of per environmental regulations.
- f. Hazards of product use and the need for protective measures (e.g., personal protective equipment, etc.) conveyed to employees.
- g. Asbestos work conforms to applicable standards.
- h. Exposure to toxic gases, vapors, fumes, dusts, and mists managed correctly.
- i. Lead, laser, and any other hazardous components managed per the applicable standard.
- j. Contract employees must conduct hazardous waste operations work within the parameters of a written

safety & health plan.

20. Comments, notes, additional requirements:

The Contractor has the ultimate responsibility for safety on the project site at all times until final completion and acceptance of the project.

The Contractor's signature below indicates the above information was discussed and understood.

Contractor signature: _____ **Date:** _____

Contracting Officer/Contracting Officer's Representative: _____ **Date:** _____

OSHA CONSTRUCTION SAFETY STANDARDS - 29 CFR 1926:

(Following standards can be accessed at <http://www.osha.gov>):

- Subpart A (1926.1 - 1926.5) - General
- Subpart B (1926.10 - 1926.16) - General Interpretations
- Subpart C (1926.20 - 1926.35) - General Safety and Health Provisions
- Subpart D (1926.50 - 1926.66) - Occupational Health and Environmental Controls
- Subpart E (1926.95 - 1926.107) - Personal Protective and Life Saving Equipment
- Subpart F (1926.150 - 1926.155) - Fire Protection and Prevention
- Subpart G (1926.200 - 1926.203) - Signs, Signals and Barricades
- Subpart H (1926.250 - 1926.252) - Materials Handling, Storage, Use and Disposal
- Subpart I (1926.300 - 1926.307) - Tools - Hand and Power
- Subpart J (1926.350 - 1926.354) - Welding and Cutting
- Subpart K (1926.400 - 1926.449) - Electrical
- Subpart L (1926.450 - 1926.454) - Scaffolds
- Subpart M (1926.500 - 1926.503) - Fall Protection
- Subpart N (1926.550 - 1926.555) - Cranes, Derricks, Hoists, Elevators and Conveyors
- Subpart O (1926.600 - 1926.606) - Motor Vehicles, Mechanized Equipment and Marine Operations
- Subpart P (1926.650 - 1926.652) - Excavations
- Subpart Q (1926.700 - 1926.706) - Concrete and Masonry Construction
- Subpart R (1926.750 - 1926.752) - Steel Erection
- Subpart S (1926.800 - 1926.804) - Underground Construction, Caissons, Cofferdams and Compressed Air
- Subpart T (1926.850 - 1926.860) - Demolition
- Subpart U (1926.900 - 1926.914) - Blasting and the Use of Explosives
- Subpart V (1926.950 - 1926.960) - Power Transmission and Distribution
- Subpart W (1926.1000-1926.1003)- Rollover Protective Structures; Overhead Protection
- Subpart X (1926.1050 -1926.1060)- Stairways and Ladders
- Subpart Y (1926.1071 -1926.1092)- Diving
- Subpart Z (1926.1100 -1926.1152)- Toxic and Hazardous Substances

